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Analysis of pesticide residues in plant-based products

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Preface

This research was performed in the context of the protein transition and the shift away from animal proteins towards the safe consumption of vegetables and new protein sources. In this report, a traditional Dutch diet, a plant-based version of this traditional Dutch diet and a plant-based diet that is not based on the traditional Dutch diet are described. A first assessment of chemical safety was made of 27 different plant-based (vegan) supermarket products, that are not (yet) included in the Dutch pesticide residue monitoring program. For this purpose, a total of 85 samples were analysed for pesticides.

Summary

In the Netherlands about 4% of the population does not eat meat and there is a growth in the number of flexitarians (people who do not eat meat at least once day a week) (de Waart, 2018).

The dietary change with a larger consumption of plant-based products raises the question of safety with regard to health of such a plant-based diet, considering intake of pesticides, other contaminants or possibly mycotoxins and phytoestrogens.

This report describes the differences between products consumed in a traditional Dutch diet, a plant-based version of this traditional Dutch diet and a plant-based diet that is not based on the traditional Dutch diet. The wide range of alternative and plant-based products offered in stores and supermarkets, facilitates the shift towards a lower consumption of animal-based products, while still maintaining a traditional Dutch diet. *Ergo* the traditional Dutch diet is adjustable into a plant-based variant. When completely switching to a plant-based diet, thus abandoning even the plant-based version of the traditional Dutch diet, significant differences are seen in dietary patterns and choice of food products. For example, there is a higher consumption of nuts, pulses and soy products like Tempé, nutritional yeast, seaweed products and certain seeds.

Based on a weekly meal plan for the three diets, a proposal is made for products that are more often consumed in a plant-based diet and are of interest for further assessment of food safety (pesticides, contaminants and other possible plant-based hazards).

Thirty six typical food items from the entirely plant-based diet (as the most extreme contrast to the traditional Dutch diet) were listed. It was verified which food products are already included in the regular Dutch pesticide residue monitoring and control program of the NVWA. For those products that were already in the monitoring program, residue data were considered to be readily available. In this study, emphasis was on chemical safety of products that were not included in the NVWA control program. In total 27 of such products were selected. Several specimens of each of these products were purchased and analysed (ranging from n=1 to n=6). A total of 85 samples were quantitatively analysed for pesticides. Approximately half of the samples were organic.

Results

Overall, 16 different residues were found, in 68 of the 85 samples. Bromide and phosphonic acid were frequently present, other pesticide residues were only found in a few samples. The findings were compared against EU Regulation 396/2005¹.

Bromide was found in 64 samples. The Maximum Residue Level (MRL) for bromide was not exceeded in any of the samples. The levels found most probably arise from natural background and are considered of no concern.

Phosphonic acid was found in 16 samples. None of the phosphonic acid levels exceeded the MRL, except one in dried apricots and one in dried plums. For apricot and plums the MRL is 2 mg/kg for fresh produce. Fresh apricots and plums contain approximately 80-90% moisture and are generally dried to a moisture concentration of around 20% (United Nations, 1996). The drying process is expected to increase the residue concentration. When assuming full concentration of the residue in the dried product due to water loss from 80% to 20%, a processing factor of 4 becomes plausible.

Therefore, the 4.3 mg/kg found in dried apricot may still be compliant with the 2 mg/kg MRL in the fresh product. For the 32 mg/kg found in dried plums, it is considered likely that the original fresh product exceeded the MRL of 2 mg/kg.

Another observation was that phosphonic acid was found in organic lentils and chickpeas (0.28-0.80 mg/kg), which is below the MRL, but indicates a possible non-compliance with the organic code of practice.

Chlorate was detected in one sample (almond milk) at 0.51 mg/kg. Chlorate is no longer approved as a pesticide since 2008 and residues found in food may also originate from disinfection of food processing excipients and equipment with chlorine, chlorine dioxide or hypochlorite (EFSA journal 2015, 13(6):4135). The default MRL of 0.01 mg/kg is under debate in the EU and, pending the

¹ <https://eur-lex.europa.eu/legal-content/NL/ALL/?uri=CELEX:32005R0396>

outcome, the NVWA has set the Dutch intervention value for chlorate at 0.1 mg/kg. The World Health Organisation has set a guideline value for chlorate for drinking water at 0.7 mg/L. The single residue value of 0.51 mg/kg in almond milk should be viewed in this perspective.

Glyphosate was detected in one sample (oat flakes) at 0.43 mg/kg, which is well below the MRL of 20 mg/kg. Nevertheless, it is remarked here that glyphosate is a strongly debated pesticide since the International Agency for Research on Cancer (IARC) has classified it as “probably carcinogenic to humans (Group 2A)”.

Azoxystrobin, Boscalid, Cyprodinil, Cyproconazole, Dimethomorph, Dodine, Famoxadone, Fluxapyroxad, Metalaxyl, Penconazole, Propiconazole, and Pyrimethanil were detected in raisins, dry apricots and rice. Seven of these residues were found in one sample of raisins only. In none of the cases the MRL was exceeded. The residues were found in non-organic products only.

Conclusion

Switching from a traditional Dutch diet (animal-based) to an adjusted plant-based Dutch diet or a non-Dutch entirely plant-based diet, will probably result in significant consumption of products that are currently not included in the Dutch monitoring programs for pesticides in food.

After analysing 27 of such products, two cases of a possible MRL-exceedance were observed (chlorate in almond milk and fosetyl/phosphonic acid in dried plums). In addition, residues of phosphonic acid were found in organic pulses, not exceeding the MRL, but possibly non-compliant with the organic code of practise. Furthermore, it is noted that because approximately half of the samples were organic, the residues found may be an underestimation for consumers that use mostly non-organic products.

This study was carried out in the period November 2019 - October 2020 as part of a joint project on safety of a plant-based diet by Wageningen Food & Biobased Research (WFBR) and Wageningen Food Safety Research (WFSR). The research was conducted independently. This report is intended for researchers from Wageningen University and Research and can be shared publicly.

1 Introduction

In the Netherlands about 4% of the population does not eat meat and there is a growth in the number of flexitarians (people who do not eat meat at least once day a week) (de Waart, 2018). Retail sales of meat and dairy alternatives in Europe have grown by almost 10% per year between 2010 and 2020 (ING, 2020). Although it was noted that meat consumption in the Netherlands seems to stabilise (Dagevos et al, 2019), there is an increased awareness on the need to change dietary patterns. Environment, health and animal welfare put pressure on production and consumption of animal products (ING, 2017). For a sustainable food supply for the growing population, a transition is needed from animal-based diets towards plant-based diets. This dietary change with a larger consumption of plant-based products, raises a possible safety concern with regard to possible hazardous constituents or contaminants within such a plant-based diet. What are the levels of pesticides, other contaminants, plant-based toxins or phytoestrogens in a plant-based diet compared to a traditional diet that is more animal-based? To answer this, factors that may form a risk for food safety have to be identified and determined.

This report aims to clarify the differences between products consumed in a traditional Dutch diet, a plant-based version of this traditional Dutch diet and a plant-based diet that is not based on the traditional Dutch diet. Based on a weekly meal plan for the three diets, a proposal was made for products that are more often consumed in a plant-based diet and are, therefore, of interest for further analysis on food safety (pesticides, contaminants etc.).

Research questions:

- Which products are characteristic of a traditional Dutch (animal-based), 'adjusted' traditional Dutch (plant-based) and an entirely plant-based diet?
- Which plant-based products are eligible for further analysis with respect to pesticides?
- To which extent are pesticide residues present in these plant based products?

This study was carried out in the period November 2019-June 2020 as part of a joint project on safety of a plant-based diet by Wageningen Food & Biobased Research (WFBR) and Wageningen Food Safety Research (WFSR). In order to assess the safety of the plant-based diet, WFSR has analysed a selection of the products from the current study for pesticides. The research was conducted independently. This report is intended for researchers from Wageningen University and Research and can be shared publicly.

2 Approach

2.1 Quick scan on the composition of traditional Dutch diets and plant-based diets

A quick scan on the composition of traditional Dutch diets and plant-based diets was conducted. It involved a desk-based investigation of secondary sources in order to contextualize the study. Searches of websites and databases such as RIVM, Elsevier and Google Scholar were conducted for scientific articles using the following keywords: 'traditional Dutch diet', 'plant-based diet', 'veganism', 'plant-based recipes', 'plant protein', 'complementary proteins' and 'deficiencies in veganism'. The snowball method was used to search for suitable articles on this subject. Publications of 2009 onwards and with an assessed level of evidence of category 2B or higher (Table 1) were included.

Table 1 Level of evidence, a hierarchy of evidence (Burns, Rohrich, & Chung, 2011)

level of evidence	Type of study
1a	Systematic reviews (with homogeneity) of randomized controlled trials
1b	Individual randomized controlled trials (with narrow confidence interval)
1c	All or none randomized controlled trials
2a	Systematic reviews (with homogeneity) of cohort studies
2b	Individual cohort study or low quality randomized controlled trials (e.g. <80% follow-up)
2c	"Outcomes" Research; ecological studies
3a	Systematic review (with homogeneity) of case-control studies
4	Case series (and poor quality cohort and case-control studies)
5	Expert opinion without explicit critical appraisal, or based on physiology, bench research or "first principles"

The dietary analysis was divided into three global topics: Traditional Dutch diet, 'adjusted' (plant-based) traditional Dutch diet and an entirely plant-based diet that is not based on the traditional Dutch diet. Based on the quick scan, for each diet a typical example of a weekly meal plan was determined. In the next step a number of plant-based products were selected for the assessment of the safety of a plant-based diet. Comparison of the weekly meal plans elucidated which products, consumed in a plant-based diet, are uncommon or less common in the traditional Dutch diet. These products have been highlighted in the meal plans and have been suggested to WFSR as candidates for further safety analysis (Annex 1).

2.2 Selection of plant based products

An overview of the traditional Dutch and typical plant-based diets is given in Chapter 3 and Annex 1. The plant-based items within these weekly menus were evaluated and ranked based on expected available pesticide monitoring information. A selection was made of the foodstuffs that lack pesticide monitoring information. This list was ranked and prioritized.

Thirty six typical food items from the entirely plant-based diet (as the most extreme contrast to the traditional Dutch diet) were listed. Food products included nuts, pulses, beans, dried fruits, coconut (-products) and vegetable milk (oat/nut/soy). WFSR verified which products are already included in the regular Dutch pesticide residue monitoring and control program of the NVWA. For those products that were already in the monitoring program, residue data were considered to be readily available. In this study, emphasis was on products that were not included in the existing NVWA program, in order to collect lacking pesticide residue data. In total 27 products were selected. Several specimens of each

of these products were purchased and analysed (ranging from n=1 to n=6). A total of 85 samples were quantitatively analysed for pesticides. Approximately half of the samples were organic. Details are provided in Table 2 and Annex 2.

Table 2 *Selected plant based products for pesticide analysis*

Plant-based product	Samples originating from conventional or organic production
Agave syrup	conventional
Almond milk	conventional & organic
Peanut oil	conventional & organic
Raisins	conventional & organic
Cashew drink	conventional
Macadamia nuts	conventional
Dried apricots	conventional & organic
Dried brown beans	conventional & organic
Dried dates	conventional & organic
Dried marrowfat peas	organic
Dried chickpeas	conventional & organic
Lentils	conventional & organic
Dried plums	conventional & organic
Dried figs	conventional & organic
Oat flakes	conventional & organic
Millet	organic
Hazelnut	conventional & organic
Coconut	organic
Rice	conventional & organic
Oat milk	conventional
Seaweed	conventional
Hazelnut milk	conventional
Coconut milk	conventional
Soy milk	conventional
Tempeh	conventional
Tofu	conventional & organic
Basil	conventional & organic

2.3 Pesticide analysis

Upon receipt by WFSR, the samples were registered in a LIMS system. Solid samples were homogenised. Samples were analysed using two methods, i.e. methods for polar and apolar pesticides.

The first method (SOP no. CHE01-WV660) was a specific method for highly polar/ionic pesticides ('SRM-pesticides'). This method included 14 pesticides and metabolites. In short, pesticides were extracted with water/methanol/1% formic acid. After dilution, the extract was analysed by LC-MS/MS using Hilic chromatography (Obelisc-N analytical column). Reporting limits varied from 0.01-0.2 mg/kg product (Annex 3).

The second method (SOP no. CHE01-WV643) was a multi-residue method including 160 pesticides (including some metabolites). The pesticides were extracted using the QuEChERS procedure (acetonitrile/water, followed by a salt-induced phase partitioning). The acetonitrile phase was cleaned by a freeze-out, diluted and then analysed by LC-MS/MS. The reporting limit was 0.01 mg/kg for each of the pesticides (Annex 3).

3 Overview of the three different diets

3.1 The traditional Dutch diet

The traditional Dutch cuisine is simplistic and straightforward (Wight, 2017). The diet contains many dairy products such as milk, cheese and butter and contains relatively many carbohydrates and fats.

The most recent food consumption survey of the Dutch population indicates that bread, cereals, rice and pasta products account for over 22% of the daily energy intake, followed by dairy products (15%) and meat (including lunch meats) (11%) (Rijksinstituut voor Volksgezondheid en Milieu, 2019). Bread, cereals, rice, and pasta are also the most important sources of carbohydrates and fiber.

Table 3 shows an example of a traditional Dutch meal plan. Usually, there are three main meals throughout the day, i.e. breakfast, lunch and dinner. Breakfast and lunch are comparable in the Dutch cuisine (Ocké, et al, 2017). These meals include bread with toppings, i.e. cheese, a wide range of lunch meats, and sweet toppings; such as sweet sprinkles and flakes ('hagelslag', 'vlokken'), chocolate spread, thick apple syrup ('appelstroop') and peanut butter. The Dutch are known for their consumption of dairy products and especially for eating cheese. Sometimes vegetables or eggs are added at lunch, for example with a healthy sandwich ('broodje gezond').

The main meal of the day is dinner, which consists of meat and potatoes and often seasonal vegetables. A typical Dutch dish consists of a combination of potatoes, vegetables and fried or stewed meat (Wannée, 2017). Also soup or pancakes can be served as main course at dinner. Common desserts in a traditional Dutch diet are yogurt or custard ('vla').

Most people have 2-3 snacks per day, such as fruit, biscuits and cakes. The Dutch eat relatively little fruit. According to the results of the Dutch food consumption survey 2012-2016, this was approximately 120 grams of fruit per day (Ocké, et al, 2017). Fruit is usually eaten in the morning during or after breakfast and as an afternoon snack. Coffee and tea breaks are frequently used as snack moments for biscuits or cake.

Table 3 A traditional Dutch meal plan

Breakfast	Lunch	Dinner	Dessert	Snacks
Bread	Bread	Vegetables	Custard/yoghurt	Fruit
Butter/margarine	Butter/margarine	Starch (eg. Potatoes)		Biscuit
Cold meat toppings	Cheese/cold meat/egg	Meat or fish		Water/tea/coffee
Sweet topping	Raw vegetables	Fats		
Tea/Coffee/milk	Fruit juice/dairy drink/tea/coffee	Gravy/sauce		
		Water		

3.2 The 'adjusted' plant-based traditional Dutch diet

More people are adopting a more plant-based diet, which is facilitated by the availability of various plant-based meat replacers, the available information on maintaining a sustainable lifestyle and on the benefits of such a lifestyle. It is possible to avoid animal products while remaining on a traditional Dutch diet. Table 4 shows an overview of a plant-based meal plan, with a similar structure as the traditional Dutch meal plan. Animal products are replaced with the most suitable plant-based alternative, such as plant milks and plant-based meat replacers.

Table 4 Adjusted traditional Dutch diet meal plan, animal products are replaced with a suitable alternative

Breakfast	Lunch	Diner	Dessert	Snacks
Bread	Bread	Vegetables	Plant-based yoghurt	Fruit
Plant-based margarine	Plant-based margarine	Starch (e.g. potatoes)		Plant-based cookie
Plant-based 'meat' or 'cheese'	Plant-based 'meat' or 'cheese'	Plant-based meat-replacer		Water/tea/coffee
Sweet topping	Raw vegetables	Plant-based fats		
Tea/Coffee	Vegetable juice/fruit juice/tea/coffee	Plant-based gravy/sauce		
		Water		

3.3 Entirely plant-based diet, not based on the traditional Dutch diet

A plant-based diet consists largely or entirely of food from plants, including vegetables, grains, nuts, seeds, legumes and fruit, with few or no animal products. The term plant-based has changed over time and there are references to vegan diets that do not contain food from animal sources, to vegetarian diets that contain eggs and dairy, but no meat, and to diets with varying amounts of animal food, such as semi-vegetarian diets that contain small amounts of meat. In this report for the entirely plant-based diet the vegan principles were followed, resulting in a diet without animal products. A vegan diet that is well-planned and balanced, will meet all recommendations for nutrients for every life stage. Improper use of the vegan diet can result in micronutrient deficiencies, such as protein, vitamin B12, vitamin D, calcium, iron, iodine, zinc and riboflavin (vitamin B2) (van Velzen, 2019). As most plant-based diets are naturally low in essential nutrients, variation, planning and creativity is a necessity for a balanced diet. Therefore, foreign and exotic products are often included in meal plans, because of the higher levels of nutrients. Also, traditional dishes with animal products are often adjusted to a plant-based homemade version, for example pastries and seasonal dishes. Table 5 presents an overview of products commonly used in an entirely plant-based diet.

Table 5 Overview of plant-based products, including nutritious foreign and exotic products

Food Group	Variations	Nutrients
Grain products, potatoes	Potatoes: any kind, a piece, mashed, fries, baked, roasted	Potassium, vitamin B6 and, dietary fiber, protein, folic acid and vitamin C
	Rice and other: any kind of whole grain, brown rice, bulgur, quinoa	Quinoa: dietary fiber, B vitamins, iron Bulgur: dietary fiber, B vitamins, iron, calcium, phosphorus, potassium, magnesium and zinc
	Any kind of plant-based pasta, noodles etc.	
Bread	Plant-based breads: Whole wheat, white, rye	Iron, dietary fiber
Fruit	Any kind: fresh, dried, frozen	Vitamin C, potassium, dietary fiber, bioactive compounds
Pastry and cake	Plant-based pastries (usually homemade): Apple pie, apple cake, carrot cake, etc.	
Flour	Any kind: whole wheat	
Vegetables	Any kind: fresh, frozen, canned	Various nutrients: e.g. calcium and iron in green leafy vegetables Iodine, vitamin C, dietary fiber
Sandwich spreads and toppings	Sweet toppings: nut butters (peanut, almond, hazelnut, macadamia nut), fruit jam and spreads	
Plant milk and plant milk products	Almond, hazelnut, coconut, soy, oat.	Fortified with calcium

Food Group	Variations	Nutrients
Nuts and seeds	Any kind of nut: Peanut, almond, hazelnut, macadamia, walnut, pecans, etc.	Calcium, omega-3 fatty acids
	Any kind of seed: sesame, chia, hemp, sunflower, pumpkin seeds, etc.	Calcium, omega-3 fatty acids
Legumes	Any kind: beans, peas, chickpeas, lentils, lupins, soybeans etc.	Protein, B vitamins and minerals, iron, calcium, molybdenum, phosphorus and dietary fiber.
Soups	Any plant-based soup: Tomato, mushroom, pumpkin, onion, broccoli, zucchini, vegetable, etc.	
Soy products and vegetarian products	Vegan burger, vegetable balls, falafel, plant based chicken bits, sea sticks, tofu, tempeh	Plant protein and unsaturated fats Calcium, fortified with vitamin B12
Sugar	Solid: granulated white sugar, coconut sugar	
	Powdered sugar	
	Syrups: agave	
Sweets and candy	Any plant-based biscuit brand	
	Plant-based cake, ontbijtkoek (spiced cake)	
Fats, oils and savoury sauces	Plant-based margarine	Fortified with vitamin A, E and D Unsaturated fats
	Plant oils: olive, sunflower, peanut, coconut, peanut, flaxseed oil,	Unsaturated fats Vitamin D, omega-3 fatty acids
Drinks	Cold drinks: plant-based soda, lemonade	
	Hot drinks: tea, coffee, plant-based hot chocolate	
	Fruit and vegetable juices: orange, mixed fruits, tomato, carrot	
	Water	
Other	Marmite, nutritional yeast, sea weed	Vitamin B12

As shown in Table 6, an entirely plant-based diet is different in product choice, with a higher consumption of legumes and starch-rich products. Hot meals are consumed during lunch and dinner, as legumes are added to both meal times. Starches and legumes can only be eaten after being cooked, as solanine in potatoes and lectin in legumes need to be rendered harmless by heating.

Table 6 A plant-based meal plan, more legumes and starch rich products are included in the plant-based diet

Breakfast	Lunch	Dinner	Dessert	Snacks
Oat or smoothie bowl	Brown rice	Vegetables	Fruit/homemade dessert	Fruit
Nuts	Plant-based fats	Starch		Plant-based snack, dried fruit
Seeds	Plant-based protein source like legumes, soy, tofu, Tempe	Plant-based protein source		Water/tea/coffee
Fruit	Raw vegetables	Plant-based fats		
Water/tea/coffee	Water/tea/coffee	Plant-based flavour		
		Water		

3.4 Comparison of the three diets

Table 7 shows an overview on the daily meal plans for all three diets. The traditional Dutch diet and the adjusted Dutch plant-based diet share the most similarities, all products are the same, with an exception of the animal products which have been replaced with suitable plant-based products. The entirely plant-based diet is considerably different from the two Dutch diets. The most distinct difference is, apart from omitting animal products, that bread is replaced by cereal products that are high in fibre. In both the Dutch diet and the adjusted Dutch diet, bread is the most important product

in breakfast and lunch, whereas the plant-based diet usually starts breakfast with oats or fruit smoothies, and has rice or quinoa with lunch.

Table 7 Overview daily meal plan of the three diets

Traditional Dutch diet	Adjusted plant-based Dutch diet	Entirely plant-based diet, not based on the traditional Dutch diet
Breakfast		
Bread	Bread	Oat or smoothie bowl
Butter/margarine	Plant-based margarine	Nuts
cold meat	Plant-based 'meat' or 'cheese'	Seeds
Sweet topping	Sweet topping	Fruit
Tea/Coffee	Tea/Coffee	Water/tea/coffee
Lunch		
Bread	Bread	Brown rice or quinoa
Butter/margarine/'halvarine'	Plant-based margarine	Plant-based fats
Cheese/cold meat toppings/egg	Plant-based 'meat' or 'cheese'	Plant-based protein source like legumes, soy, tofu, tempé
Raw vegetables	Raw vegetables	Raw vegetables
Fruit juice/dairy drink/tea/coffee	Vegetable juice/fruit juice/tea/coffee	Water/tea/coffee
Dinner		
Vegetables	Vegetables	Vegetables
Starch (e.g. potatoes)	Starch (e.g. potatoes)	Starch
Meat or fish	Plant-based meat-substitute	Plant-based protein source
Fats	Plant-based fats	Plant-based fats
Gravy/sauce	Plant-based gravy/sauce	Plant-based flavour
Water	Water	Water
Dessert		
Custard/yoghurt	Plant-based yoghurt	Fruit
Snacks		
Fruit	Fruit	Fruit
Cookie	Plant-based cookie	Plant-based snack, dried fruit
Water/tea/coffee	Water/tea/coffee	Water/tea/coffee

Based on the information gathered on the three different diets, three examples of weekly meal plans have been proposed (Annex 1). The main products that are different in a plant-based diet compared to the traditional Dutch diet have been highlighted in green, in order to facilitate the selection of plant-based products for the analysis of possible pesticide residues.

4 Results of the pesticide analysis in selected plant based products

In total 27 products were selected. Several variants (ranging from n=1 to n=6) of each of these products were purchased and a total of 85 samples were quantitatively analysed for pesticides. Approximately half of the samples were organic.

In 22 of the 27 products residues were detected. Overall, 16 different residues were found, in 68 of the 85 samples. (see Table 8 and Annex 4).

Bromide (in 20 products) and phosphonic acid (in 9 products) were frequently present, other residues only in a few cases (in 5 products). The findings were compared against EU Regulation 396/2005². Below some short remarks are provided on the findings.

Bromide: detected in 20 products (64 out of 85 samples), at levels ranging from 0.1 to 16 mg/kg. Bromide is regulated as a marker for the no longer approved pesticide methyl bromide. However, the marker is not unique for methyl bromide. Bromide is present in soil and results in a natural background in crops. The Maximum Residue Levels (MRLs) range from 20-50 mg/kg for most crops. This MRL was not exceeded in any of the samples. The levels found are considered to arise from natural background and are of no concern.

Phosphonic acid: phosphonic acid is a metabolite of the fungicide fosetyl and included in its residue definition (i.e. the sum of fosetyl, phosphonic acid and their salts, expressed as fosetyl). Phosphonic acid may also originate from application of potassium phosphonates as fungicide. In the current study, phosphonic acid was found in 9 products (16 out of 85 samples), mostly below 2 mg/kg. Higher levels were found in raisins, macadamia nuts, dried apricot and dried plums. For grapes and nuts, MRLs are high (100-500 mg/kg). For apricot and plums the MRL is 2 mg/kg for fresh produce. For dried fruits, a processing factor needs to be taken into account when comparing the level found with the MRL. Since for phosphonic acid no established processing factors could be found, only a qualitative estimate could be made here. Fresh apricots and plums contain approximately 80-90% moisture and are generally dried to a moisture concentration of around 20% (United Nations, 1996). The drying process is expected to increase the concentration and considering a full concentration of the residue in the dried product due to water loss from 80% to 20%, a processing factor of 4 is plausible. For this reason, the 4.3 mg/kg found in dried apricot may still be compliant with the 2 mg/kg MRL. For the 32 mg/kg found in dried plums, it is considered likely that the original fresh product exceeded the MRL of 2 mg/kg.

Another observation was that phosphonic acid was found in organic lentils and chickpeas (0.28-0.80 mg/kg), which is below the MRL, but indicates a possible non-compliance with the organic code of practice.

Chlorate: detected in one product (almond milk) at 0.51 mg/kg (1 out of 85 samples). Chlorate was used as pesticide until 2008, and since then the default MRL of 0.01 mg/kg applies. However, chlorate can also be formed as a by-product when using chlorine, chlorine dioxide or hypochlorite for the disinfection of drinking water, water for food production and surfaces coming into contact with food (EFSA journal 2015, 13(6):4135). Chlorate residues in food are mainly resulting from the use of chlorinated water for food processing (e.g. washing) and from the disinfection of surfaces and food processing equipment coming into contact with food. Monitoring data indicate that the default 0.01 mg/kg MRL is frequently exceeded and setting MRLs for chlorate in regular food at levels based on occurrence data is needed (except for food intended for infants and young children). However, to date, no adjusted MRLs have been set at an EU level. At a national level in The Netherlands, the competent authority (NVWA³) has set a national intervention value, i.e. 0.1 mg/kg,

² <https://eur-lex.europa.eu/legal-content/NL/ALL/?uri=CELEX:32005R0396>

³ <https://www.nvwa.nl/onderwerpen/inspectieresultaten-bestrijdingsmiddelen-in-voedingsmiddelen/wettelijke-normen-resten-bestrijdingsmiddelen-in-voedingsmiddelen/interventiewaarden-voor-chloraat-in-levensmiddelen>

above which enforcement action can be taken. The World Health Organisation (WHO) has, using a TDI of 30 µg/kg of body weight, a typical human body weight of 60 kg, the assumption that drinking-water contributes 80% of the total exposure and a typical consumption of 2 litres of water per day, calculated a guideline value for chlorate of 0.7 mg/L⁴.

The level of chlorate found in the sample obviously exceeds the 0.01 mg/kg default MRL, as well as the Dutch intervention value of 0.1 mg/kg, but remains below the WHO guideline value of 0.7 mg/L. In the present study, six different almond milk samples were analysed, of which five did not show chlorate residues. It is considered unlikely that the single residue originates from a pesticide application.

Glyphosate: detected in one product (oat flakes) at 0.43 mg/kg (1 out of 85 samples). For oats, a MRL of 20 mg/kg applies. Therefore, the level found is considered to be compliant with current EU legislation. Nevertheless, it is remarked here that glyphosate is a strongly debated pesticide since the International Agency for Research on Cancer (IARC) has classified it as “probably carcinogenic to humans (Group 2A)”.

Various pesticides: Azoxystrobin, Boscalid, Cyprodinil, Dimethomorph, Famoxadone, Fluxapyroxad, Metalaxyl, Penconazole and Pyrimethanil were detected in one product (raisins; 1 out of 85 samples), Dodine was detected in one product (dry apricots; 1 out of 85 samples) and Azoxystrobin, Cyproconazole and Propiconazole were detected in one product (rice; 1 out of 85 samples). In none of the cases the MRL was exceeded. The residues were found in non-organic products only.

Table 8 Overview of residues in selected plant based products (mg/kg)

Plant based product	Bromide	Chlorate	Glyphosate	Phosphonic acid	Azoxystrobin	Boscalid	Cyprodinil	Cyproconazole	Dimethomorph	Dodine	Famoxadone	Fluxapyroxad	Metalaxyl	Penconazole	Propiconazole	Pyrimethanil
Agave syrup																
Almond milk	0.25	0.51		0.35												
	0.36			0.36												
	0.14															
	0.25															
	0.23															
	0.14															
Peanut oil																
Raisins				1.77	0.02	0.26	0.30		0.02		0.14	0.01	0.19	0.03		0.73
				7.86												
Cashew drink	0.12			0.04												
	0.46			0.06												
Macadamia nuts	0.76			10.4												
	4.73															
Dried apricots	14.5			4.32						0.03						
Dried brown beans	0.27															
	0.26															
	1.53															
Dried dates	2.30															
	3.75															
	3.05															
Dried marrowfat peas	6.10															
	3.44															

⁴ https://www.who.int/water_sanitation_health/dwq/chemicals/chlorateandchlorite0505.pdf

Plant based product	Bronide	Chlorate	Glyphosate	Phosphonic acid	Azoxystrobin	Boscalid	Cyprodinil	Cyproconazole	Dimethomorph	Dodine	Famoxadone	Fluxapyroxad	Metaxyl	Penconazole	Propiconazole	Pyrimethanil
Dried chickpeas	3.06			0.43												
	1.60			0.28												
	2.01															
Lentils	2.61			0.65												
	11.3			0.80												
	2.69															
	4.64															
	4.10															
	3.46															
	4.29															
	2.25															
	2.34															
	2.81															
Dried plums				32.0												
Dried figs	6.26															
	5.37															
	3.59															
Oat flakes	1.35		0.43													
	2.27															
	1.11															
	3.22															
	0.67															
Millet	3.52															
Hazelnut																
Coconut	2.38															
	2.22															
	4.44															
Rice	0.18				0.01			0.07								0.12
	0.24															
Oat milk	0.32			0.03												
	0.32			0.08												
	0.39			0.13												
Seaweed	16.3															
Hazelnut milk	0.14															
	0.20															
Coconut milk	0.76															
	0.47															
	0.64															
Soya milk	0.17															
	0.14															
	0.20															
Tempeh																
Tofu																
Basil	12.3															
	10.1															
	12.2															

5 Conclusion

An increasing number of people in the Netherlands is switching to a more plant-based diet. The wide range of alternative and plant-based products offered in stores, facilitates this switch towards a lower consumption of animal-based products, while still maintaining a traditional Dutch diet. The traditional Dutch diet is easily adjustable to a plant-based variant. When completely switching to a plant-based or vegan diet, not based on the traditional Dutch diet, differences are seen in dietary patterns and choice of food products. For example, there is a higher consumption of cereals, nuts, pulses and soy products like tempé, nutritional yeast, sea weed products and certain seeds.

The comparison of three weekly meal plans, based on a traditional Dutch diet (animal-based), an adjusted plant-based Dutch diet and an entirely plant-based diet, not based on the traditional Dutch diet reveals a number of products that are more consumed in the latter diet. Twenty seven of these products have been analysed for pesticides, in order to assess the chemical safety of such an entirely plant-based diet.

In total 85 samples of products of a typical vegan diet, for which no or only limited pesticide residue data is available in existing Dutch monitoring programs, were analysed. Residues were found in 68 samples. In most cases this was due to the presence of bromide, which also occurs naturally. No MRL-exceedances for bromide were observed. Excluding bromide from the data, residues were found in 18 out of the 85 samples. In two cases a possible MRL-exceedance was observed (chlorate in almond milk and fosetyl/phosphonic acid in dried plums). In addition, residues of phosphonic acid were found in organic pulses, not exceeding the MRL, but possibly non-compliant with the organic code of practise.

It should be remarked that because approximately half of the samples were organic, the residues found may be an underestimation for consumers that use mostly non-organic products.

References

- Burns, P. B., Rohrich, R. J., & Chung, K. C., 2011. The Levels of Evidence and Their Role in Evidence-Based Medicine. *Plastic and Reconstructive Surgery*, 128(1), 305–310.
<https://doi.org/10.1097/prs.0b013e318219c171>
- Dagevos, H., Verhoog, D., van Horne, P., and Hoste, R., 2019. Vleesconsumptie per hoofd van de bevolking in Nederland, 2005-2018. <https://library.wur.nl/WebQuery/wurpubs/fulltext/499852>
- de Waart, S., 2018. Factsheet Consumptie Cijfers en aantallen vegetariërs (1). Retrieved from <https://www.vegetariërs.nl/serverspecific/default/images/File/Factsheet1Consumptiecijfersenaantallenvegetariërsmaart2018.pdf>
- EFSA Panel on Contaminants in the Food Chain. Risks for public health related to the presence of chlorate in food. <https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2015.4135>
- Glyphosate. IARC Monograph, 2018. <https://monographs.iarc.fr/wp-content/uploads/2018/06/mono112-10.pdf>
- ING, 2017. The protein shift: will Europeans change their diet?
https://think.ing.com/uploads/reports/ING_The_protein_shift_will_Europeans_change_their_diet.pdf.
- ING, 2020. Growth of meat and dairy alternatives is stirring up the European food industry.
https://think.ing.com/uploads/reports/ING_report_-_Growth_of_meat_and_dairy_alternatives_is_stirring_up_the_European_food_industry.pdf
- Ocke, M., van Rossum, C., Buurma-Rethans, E., Vennemann, F.B.C., Beukers, M., Brants, H.A.M. and de Boer, E., 2017. The diet of the Dutch Results of the first two years of the Dutch National Food Consumption Survey 2012-2016 (2016-0082). Retrieved from <https://www.rivm.nl/bibliotheek/rapporten/2016-0082.pdf>
- Pimentel, D., and Pimentel, M., 2003. Sustainability of meat-based and plant-based diets and the environment. *The American Journal of Clinical Nutrition*, 78(3), 660S-663S.
<https://doi.org/10.1093/ajcn/78.3.660s>
- Rijksinstituut voor Volksgezondheid en Milieu, 2019. Bronnen van energie en macronutriënten. Retrieved December 4, 2019, from <https://www.waeteetnederland.nl/resultaten/energie-en-macronutriënten/bronnen>
- SOPCHE01-WV660, 2019. Bepaling van polaire bestrijdingsmiddelen in plantaardige producten m.b.v. vloeistofchromatografie-tandem-massaspectrometrie (SRM-2) - WFSR
- SOPCHE01-WV643, 2019. De bepaling van bestrijdingsmiddelen in land- en tuinbouwproducten, levensmiddelen en producten van dierlijke oorsprong m.b.v. vloeistofchromatografie – massaspectrometrie [LC-MS/MS (TQ-ESI)] - QuEChERS methode - WFSR
- United Nations, 1996. UNECE Standard DDP-15 concerning the marketing and commercial quality control of Dried Apricots
- van Velzen, D., (June 3), 2019. Voedingsstoffen - Nederlandse Vereniging voor Veganisme. Retrieved December 4, 2019, from <https://www.veganisme.org/voeding/voedingsstoffen/>
- Wannée, C. J., 2017. Wannée: kookboek van de Amsterdamse huishoudschool (Dutch Edition) (01 ed.). Amsterdam: Becht.
- Wight, E., 2017. Dutch Feast. Retrieved from <https://books.google.nl/books?id=PXG4DgAAQBAJ&lpg=PT12&dq=history%20dutch%20cuisine&hl=nl&pg=PT12#v=onepage&q=history%20dutch%20cuisine&f=false>

Annex 1 Examples of weekly meal plans for the three diets

Traditional Dutch diet: a weekly meal plan

Breakfast	Lunch	Dinner	Dessert	Snacks
Monday				
Typical Dutch breakfast	Tomato soup	Meatless Monday: Cauliflower casserole	Dessert	
2 slices of whole wheat bread	1 bowl of tomato soup	2 servings cauliflower and leak	1 serving of custard (vla)	1 serving of fruit
1 serving of margarine	2 slices of baguette	2 servings boiled potatoes	½ serving of fruits	Biscuits
1 serving of chicken	2 servings of garlic butter	2 eggs		Tea with milk
1 serving of fruit sprinkles	Water	1 to 2 servings of cooking fats		Water
Coffee		1 serving crème fraîche		Coffee
		1 serving of mustard		
		1 glass of fruit juice		
Tuesday				
Typical Dutch breakfast	Egg sandwich	Typical dutch: Potatoes-Veggie-Meat	Dessert	
2 slices of rye bread	2 slices of whole wheat bread	1 serving snap beans	1 serving of yogurt	1 serving of fruit
1 serving of butter	1 serving of mayonnaise	1 serving boiled potatoes	½ serving of fruits	1 small bar of milk chocolate
1 serving of cheese	2 eggs, scrambled	1 serving grilled chicken		Tea with milk
1 serving of jam	1 small salad: tomatoes, cucumber and lettuce	2 servings of cooking fats		Water
Tea with milk	1 glass of fruit yogurt drink	1 serving gravy		
		1 glass fruit juice		
Wednesday				
Typical Dutch breakfast	Healthy deli sandwich	Leftovers: Cauliflower casserole	Dessert	
2 slices of whole wheat bread	2 slices of whole wheat bread	1 serving of Cauliflower casserole (see Monday)	1 serving of custard (vla)	1 serving of fruit
1 serving of margarine	1 serving of mayonnaise	1 serving bacon	½ serving of fruits	1 slice of apple pie
1 serving of bologna sausage	1 serving of as turkey	1 small salad: tomatoes, cucumber and lettuce		Coffee
½ serving of peanut butter	1 serving of cheese	1 glass of fruit juice		
½ serving of milk chocolate sprinkles	½ egg, sliced			
1 glass of milk	Lettuce, slices of tomatoes and cucumber			
	1 glass fruit juice			
Thursday				
Typical Dutch breakfast	Tosti (grilled cheese sandwich)	Hutspot (carrot and potato hotchpot)	Hangop (Dutch curd)	
2 slices of ginger cake (ontbijtkoek)	2 slices of whole wheat bread	1 serving carrots and onions	1 serving curd (hangop)	1 serving of fruit
1 serving of butter	1 serving of butter	1 serving mashed potatoes	½ serving of fruits and syrup	Biscuits
Tea	1 serving of ham	1 serving pork sausage		Coffee
	1 serving of cheese	1 serving of cooking fats		

Breakfast	Lunch	Dinner	Dessert	Snacks
	1 serving of ketchup	1 serving meat gravy		
	1 glass fruit juice	Water		
Friday				
Peanut butter-Jelly sandwich	Pea soup	Friday-fish day	Dessert	
2 slices of whole wheat bread	1 bowl of pea soup	1 serving spinach	1 serving of custard (vla)	1 serving of fruit mix
1 serving of butter	1 serving of Dutch smoked sausage (rookworst)	1 serving baked potatoes	½ serving syrup	Biscuits
1 serving of peanut butter	2 slices of rye bread with butter	1 serving breaded plaice		Tea
1 serving of strawberry jam	Water	2 servings of cooking fats		Water
Tea		1 serving ravigote sauce		
		1 glass of fruit juice		
Saturday				
Typical Dutch breakfast	Large salad	French fries	Ice cream	
2 slices of whole wheat bread	Lettuce, spinach, peas, tomatoes and cucumber	1 serving of potato fries	2 scoops of strawberry and vanilla ice cream	1 serving of fruit
1 serving of margarine	½ serving of chicken breast, grilled	1 serving of mayonnaise		Biscuits
1 serving of ham	1 egg, sliced	1 beef croquette		Tea
1 serving milk chocolate sprinkles	1 serving of white balsamic vinegar dressing	1 serving of mustard		Water
Tea with milk	1 glass fruit juice	1 small salad: tomatoes, cucumber and lettuce		
		1 glass of orange soda		
Sunday				
Typical Dutch breakfast	Healthy deli sandwich	Dutch pancakes	Cappuccino	
2 slices of whole wheat bread	2 slices of whole wheat bread	3 pancakes	1 cappuccino	1 serving of fruit
1 serving of butter	1 serving of mayonnaise	1 serving of powdered sugar and berries		Cake
1 serving of ham	1 serving of turkey	1 serving bacon		Tea
1 serving of jam	1 serving of cheese	1 glass milk		Water
Coffee	½ egg, sliced			
	Slices of tomatoes and cucumber			
	Lettuce and coleslaw			
	1 glass of orange juice			

Adjusted plant-based Dutch diet: a weekly meal plan

The main products that are different in a plant-based diet compared to the traditional Dutch diet have been highlighted in green, in order to facilitate the selection of plant-based products for the analysis of possible pesticide residues.

Breakfast	Lunch	Dinner	Dessert	Snacks
Monday				
Typical Dutch breakfast	Tomato soup	Cauliflower casserole	Dessert	
2 slices of whole wheat bread	1 bowl of tomato soup	2 servings cauliflower and leak	1 serving of soya yogurt	1 serving of fruit
1 serving of plant margarine	2 slices of baguette with olive oil and garlic	2 servings cooked potatoes	½ serving of fruits	Plant based biscuits
1 serving of plant based chicken	Water	1 serving of tofu		Tea with oat milk
1 serving of fruit sprinkles		1 serving of vegetable oil		Water
Coffee		1 serving plant based crème and mustard		Coffee
		1 glass of fruit juice		
Tuesday				
Typical Dutch breakfast	Grilled veggie sandwich	Typical dutch: Potatoes-Veggie-Meat	Dessert	
2 slices of rye bread	2 slices of whole wheat bread	1 serving snap beans	1 serving of soya yogurt	1 serving of fruit
1 serving of plant margarine	1 serving of plant based mayonnaise	1 serving cooked potatoes	½ serving of fruits	1 small bar of dark chocolate
1 serving of plant cheese	½ grilled bell pepper, eggplant, mushrooms	1 serving plant based chicken bits		Tea with almond milk
1 serving of jam	1 small salad: tomatoes, cucumber and lettuce	2 servings of vegetable oil		Water
Tea with almond milk	1 glass fruit juice	1 serving vegetable based onion gravy		Coffee
		1 glass fruit juice		
Wednesday				
Typical Dutch breakfast	Healthy deli sandwich	Leftovers: Cauliflower casserole with salad	Dessert	
2 slices of whole wheat bread	2 slices of whole wheat bread	1 serving of cauliflower casserole	1 serving of soya yogurt	1 serving of fruit
1 serving of plant margarine	1 serving of plant mayonnaise and mustard	1 serving plant based cheese	½ serving of fruits	1 slice of dairy free, egg free apple cake
1 serving of plant based bologna sausage	1 serving of plant based deli chicken	1 small salad: tomatoes, cucumber and lettuce		Coffee
½ serving of peanut butter	1 serving of plant based cheese	1 glass of fruit juice		Water
½ serving of dark chocolate sprinkles	Lettuce, slices of tomatoes and cucumber			Tea
1 glass of oat milk	1 glass fruit juice			
Thursday				
Typical Dutch breakfast	Tosti (grilled cheese sandwich)	Hutspot (carrot and potato hotchpot)	Plant based hangop (Dutch curd)	
2 slices of ginger cake (ontbijtkoek)	2 slices of whole wheat bread	1 serving carrots and onions	1 serving plant based curd	1 serving of fruit
1 serving of plant margarine	1 serving of butter	1 serving mashed potatoes	½ serving of fruits and syrup	Plant based biscuits
Tea	1 serving of plant based chicken	1 serving plant based sausage		Coffee
	1 serving of plant based cheese	2 servings of vegetable oil and plant margarine		

Breakfast	Lunch	Dinner	Dessert	Snacks
	1 serving of ketchup	1 serving vegetable gravy		
	1 glass fruit juice	1 glass of water		
Friday				
Peanut butter-Jelly sandwich	Pea soup	Fishless Friday	Dessert	
2 slices of whole wheat bread	1 bowl of pea soup	1 serving spinach	1 serving of soya yogurt	1 serving of fruit mix
1 serving of plant margarine	1 serving of vegan Dutch smoked sausage	1 serving baked potatoes	½ serving syrup	Plant based biscuits
1 serving of peanut butter	2 slices of rye bread	1 serving sea sticks (plant based fish substitute)		Tea
1 serving of strawberry jam	2 servings of plant margarine	2 servings of vegetable oil		Water
Tea	Water	1 serving plant-based mayonnaise		Coffee
		1 glass of fruit juice		
Saturday				
Typical Dutch breakfast	Big salad	French fries	Sorbet ice	
2 slices of whole wheat bread	Lettuce, spinach, peas, tomatoes and cucumber	1 serving of potato fries	1 to 2 scoops of strawberry and lemon sorbet	1 serving of fruit
1 serving of plant margarine	½ serving of plant based chicken, grilled	1 serving of plant mayonnaise		Plant based biscuits
1 serving of plant based chicken	1 serving of grated plant based cheese	1 vegetable croquette		Tea
1 serving dark chocolate sprinkles	1 serving of white balsamic vinegar dressing	1 serving of mustard		Water
Tea with almond milk	1 glass fruit juice	1 small salad: tomatoes, cucumber and lettuce		Coffee
		1 glass of orange soda		
Sunday				
Typical Dutch breakfast	Healthy deli sandwich	Dutch pancakes	Cappuccino	
2 slices of whole wheat bread	2 slices of whole wheat bread	3 plant based pancakes	1 cappuccino with almond milk	1 serving of fruit
1 serving of plant margarine	1 serving of plant mayonnaise	1 serving of powdered sugar and berries		Dairy free, egg free cake
1 serving of plant based chicken	1 serving of plant based chicken	1 serving plant based cheese		Tea
1 serving of jam	1 serving of plant based cheese	1 glass of almond milk		Water
Coffee	Lettuce, slices of tomatoes and cucumber			Coffee
	1 glass of orange juice			

Entirely plant-based diet, not based on the traditional Dutch diet: a weekly meal plan

The main products that are different in a plant-based diet compared to the traditional Dutch diet have been highlighted in green, in order to facilitate the selection of plant-based products for the analysis of possible pesticide residues.

Breakfast	Lunch	Dinner	Dessert	Snacks
Monday				
Smoothie bowl	Veggie poké bowl	Vegan Greek pasta salad	Banana and nuts treat	
2½ servings of berries and banana	1 serving brown rice	2 servings of fusilli whole wheat pasta	1 serving of banana puree	1 serving of dried fruits
1 serving almond butter	1 serving peanut butter	½ serving of chickpeas	½ serving of agave syrup	1 serving of mixed nuts
½ serving chia seeds	1 serving tempeh	½ serving of red bell pepper dices	½ serving of sliced almonds	Tea with oat milk
½ serving fruits	1 serving peas and carrots, cooked	½ serving of cherry tomatoes, cucumber slices		Water
Water	½ serving peanut oil	½ serving of olives and red onion slices		Coffee
Tea	1 serving soy sauce and sriracha hot sauce	½ serving of dille, minced		
	1 glass of tomato juice	1 glass of water with lemon		
Tuesday				
Carrot cake smoothie	Indian veggie salad	Vegan spaghetti	Fruit salad	
1 serving of carrots, peeled and grated	2 pappadums	1 cup whole wheat pasta	1 serving of mixed fruits	1 serving of dried fruits
1 serving of macadamia milk	1 handful of washed lamb's lettuce	2 cups homemade tomato sauce	1 tbsp of agave syrup	1 serving of mixed nuts
3 tbsp raisins	1 tomato	2 tbsp of olive oil		Tea with oat milk
1 banana, frozen	a substantial piece of cucumber (peeled)	5 homemade chickpea spaghetti balls		Water
1 tsp vanilla extract	½ avocado	1 glass of water with lemon slices		Coffee
Tea	½ spring onion			
Water	1 small pickle			
	1 serving of dressing based on tahini			
	Water			
Wednesday				
Oatmeal breakfast	Vegan wraps	Bok Choy Curry	Mango treat	
1 serving of oat flakes	2 wraps	1 cup bok choy	1 serving of mango puree	1 serving of dried fruits
1 cup of almond drink	1 serving of mixed beans	1 cup of coconut milk	½ serving of agave syrup	1 serving of mixed nuts
1 tbsp hazelnuts and macadamia nuts, crushed	1 tbsp of hummus	½ onion	½ serving of macadamia nuts, crushed	Tea with oat milk
1 tsp of chia seeds	1 serving of cucumber in strips	1 glass of water with lemon slices	coconut shavings	Water
1 serving of strawberries and raspberries	½ avocado in strips			Coffee
Water	Lettuce			
Tea	4 cherry tomatoes			
	1 glass of water with lemon slices			
Thursday				
Coconut breakfast with raspberry sauce	Mexican meal salad with millet	Dahl	Pineapple treat	
½ cup of oat flakes	1 cup millet (gerst)	1 cup of red lentils	1 serving of pineapple	1 serving of fruits
½ cup almond drink	½ cup black beans, corn, grated carrot	Onion	1 tbsp agave syrup	Banana bread with blueberries

Breakfast	Lunch	Dinner	Dessert	Snacks
¼ cup dates	1 tomato, in cubes	½ tbsp ginger, grated	1 tsp coconut sugar	Tea with oat milk
¼ cup toasted coconut, shavings	1 tsp of agave	1 cup of coconut milk		Water
½ banana	2 tablespoons lemon juice	1 cup of tomato cubes		Coffee
1 handful of raspberries, in puree	1 handful of fresh coriander, sliced	1 handful coconut shredded, toasted		
Water	1 glass of water with lemon slices	1 cup cooked rice		
Tea		1 glass of water with lemon slices		
Friday				
Oatmeal breakfast	Lentil salad with baked sweet potato	Sea weed pasta	Sticky rice mango	
1 serving of oat flakes	1 cup lentils	½ pack of Sea weed Pasta	1/4 cup sweet rice	1 serving of dried fruits
1 cup of almond drink	¼ cup peas	1 avocado	1/3 cup coconut milk	1 serving of mixed nuts
1 tbsp of each raisins, apricots, and cranberries	1 large sweet potato	2 tbsps capers	3 tbsps sugar	Tea with oat milk
1 tsp of linseed	½ pomegranate	1 tbsp of lime juice	sesame seeds, toasted lightly	Water
½ banana, sliced	juice of lemon	1 glass of water with lemon slices	½ large mango	Coffee
Water	A dressing of tahini, agave syrup and water			
Tea	1 tbsp of olive oil			
	Tea			
Saturday				
Chai pancakes	Vegan fast food: Kapsalon	Risotto	Nice-cream	
½ cup of spelled flour	2 sweet potato, cut into thin "fries"	1 cup oyster and chestnut mushrooms	3 scoops of frozen banana only ice cream	1 serving of dried fruits
1 cup cashew milk	1 teaspoon coconut oil, melted	½ an onion	3 tbsps of melted dark chocolate	1 slice of vegan carrot cake
Water	5 falafel balls	1 handful spinach	1 tbsp of toasted hazelnuts, crushed	Tea with oat milk
Tea	2 tbsp 'cheese' sauce (made of soy milk, noble yeast flakes, miso, cornflour)	½ cube vegetable stock	1 tsp coconut sugar	Water
	lettuce, tomato, cucumber and red onion	½ cup grated vegan cheese		Coffee
	1 tbsp garlic sauce (recipe below)	1 cup risotto rice		
	1 tbsp sambal badjak	½ glass of vegan dry white wine		
	1 glass of Frizz-Kola	1 glass of water with lemon slices		
Sunday				
Oatmeal breakfast	Vegan sushi	Homemade vegan pizza	Vegan hot chocolate	
1 serving of oat flakes	2 Nori sheets	1 package of fresh pizza dough from Tante Fanny	Vegan hazelnut chocolate milk	1 serving of dried fruits
1 cup of almond drink	1 cup sushi rice	1 zucchini, sliced paper-thin (with a mandolin)		Homemade vegan coconut gingerbread
1 tbsp almonds, crushed	3 tsp rice vinegar	½ sweet onions		Tea with oat milk
1 tsp of linseed	1 avocado	1 tbsp agave syrup		Water
1 peach, sliced	½ cucumber	3 tbsps of vegan pesto		Coffee
Water	½ spring onion	1 handful of pine nuts		
Tea	4 tbsps of soy sauce	1 glass of Frizz-Kola		
	1 tsp of sesame seeds			
	Tea			

Annex 2 Plant based products selected for pesticide analysis

Sample no	Sample type	Sample detail (Product-Brand-Serial number)	remark
200571715	Agave syrup	Agavesiroop-Melvita-01	
200571716	Agave syrup	Agavesiroop-Yakso-02	
200571717	Agave syrup	Agavesiroop-YourNature-03	
200571718	Almond milk	Amandelmelk-AlproBio-04	organic
200571719	Almond milk	Amandelmelk-AH-05	
200571720	Almond milk	Amandelmelk-Zonnatura-06	
200571721	Almond milk	Amandelmelk-Provamel-07	
200571722	Almond milk	Amandelmelk-Alpro-08	
200571723	Almond milk	Amandelmelk-Isola-09	
200571724	Peanut oil	Arachideolie-BioPlanete-10	organic
200571725	Peanut oil	Arachideolie-AH-11	
200571726	Raisins	GeleRozijnen-AH-12	
200571727	Raisins	BruineRozijnen-DeNieuweBand-13	organic
200571728	Raisins	Bruine rozijnen-AH-14	
200571729	Cashew drink	Cashewdrink-RudeHealth-15	
200571730	Cashew drink	Cashewdrink-Alpro-16	
200571731	Macadamia nuts	Macadamianoten-AH-17	
200571732	Macadamia nuts	Macadamianoten-Jumbo-18	
200571733	Dry apricot	GedroogdeAbrikozen-DeNieuweBand-19	organic
200571734	Dry apricot	GedroogdeAbrikozen-AH-20	
200571735	Dry apricot	GedroogdeAabrikozen-Ekoplaza-21	organic
200571736	Dry beans	GedroogdeBruineBonen-AHBio-22	organic
200571737	Dry beans	GedroogdeBruineBonen-DeNieuweBand-23	organic
200571738	Dry beans	GedroogdeBruineBonen-HAK-24	
200571739	Dry dates	GedroogdeDadels-AH-25	
200571740	Dry dates	GedroogdeDadels-DeNieuweBand-26	organic
200571741	Dry dates	GedroogdeDadels-Ekoplaza-27	organic
200571742	Dry marrowfat peas	GedroogdeKapucijners-DeNieuweBand-28	organic
200571743	Dry marrowfat peas	GedroogdeKapucijners-Ekoplaza-29	organic
200571744	Dry chickpeas	GedroogdeKikkererwtten-AHBio-30	organic
200571745	Dry chickpeas	GedroogdeKikkererwtten-Ekoplaza-31	organic
200571746	Dry chickpeas	GedroogdeKikkererwtten-Jumbo-32	
200571747	Dry chickpeas	GedroogdeKikkererwtten-DeNieuweBand-33	organic
200571748	Lentils	GedroogdeLinzen-DeNieuweBand-34	organic
200571749	Lentils	GedroogdeLinzen-Ekoplaza-35	organic
200571750	Lentils	GedroogdeLinzen-Ekoplaza-36	organic
200571751	Lentils	GedroogdeLinzen-HAK-37	
200571752	Lentils	GedroogdeLinzen-DeNieuweBand-38	organic
200571753	Lentils	GedroogdeLinzen-AHBio-39	organic
200571754	Lentils	GedroogdeLinzen-AHBio-40	organic
200571755	Lentils	GedroogdeLinzen-AHBio-41	organic
200571756	Lentils	GedroogdeLinzen-DeNieuweBand-42	organic
200571757	Lentils	GedroogdeLinzen-DeNieuweBand-43	organic
200571758	Dry plums	GedroogdePruimen-DeNieuweBand-44	organic
200571759	Dry plums	GedroogdePruimen-AH-45	
200571760	Dry plums	GedroogdePruimen-Ekoplaza-46	organic
200571761	Dry figs	GedroogdeVijgen-DeNieuweBand-47	organic
200571762	Dry figs	GedroogdeVijgen-AH-48	
200571763	Dry figs	GedroogdeVijgen-Ekoplaza-49	organic
200571764	Oat flakes	Havermoutvlokken-Quaker-50	
200571765	Oat flakes	Havermoutvlokken-Smaakt-51	organic

Sample no	Sample type	Sample detail (Product-Brand-Serial number)	remark
200571766	Oat flakes	Havermoutvlokken-MeestersVanDeHalm-52	organic
200571767	Oat flakes	Havermoutvlokken-AHBio-53	organic
200571768	Oat flakes	Havermoutvlokken-Demeter-54	organic
200571769	Oat flakes	Havermoutvlokken-AHBasic-55	
200571770	Millet	Gierst-DeNieuweBand-56	organic
200571771	Hazelnut	Hazelnuten-DeNieuweBand-57	organic
200571772	Hazelnut	Hazelnuten-AH-58	
200571773	Hazelnut	Hazelnuten-Ekoplaza-59	organic
200571774	Coconut	Kokosvlokken-AHBio-60	organic
200571775	Coconut	Kokosvlokken-DeNieuweBand-61	organic
200571776	Coconut	Kokosvlokken-Ekoplaza-62	organic
200571777	Rice	Zilvervliesrijst-DeNieuweBand-63	organic
200571778	Rice	Zilvervliesrijst-AHBasic-64	
200571779	Rice	Zilvervliesrijst-Ekoplaza-65	organic
200571780	Oat milk	Haverdrink-AH-66	
200571781	Oat milk	Haverdrink-Oatly-67	
200571782	Oat milk	Haverdrink-Lima-68	
200571783	Seaweed	Zeewierpasta-Samasaya-69	
200571784	Coconut milk	Kokosmelk-AH-70	
200571785	Coconut milk	Kokosmelk-Fairtrade-71	
200571786	Coconut milk	Kokosmelk-Amaizin-72	
200571787	Hazelnut milk	Hazelnootdrink-Zonnatura-73	
200571788	Hazelnut milk	Hazelnootdrink-Isola-74	
200571789	Soya milk	Sojadrink-Alpro-75	
200571790	Soya milk	Sojadrink-Provamel-76	
200571791	Soya milk	Sojadrink-Isola-77	
200571792	Tempeh	Tempeh-Yakso-78	
200571793	Tempeh	Tempeh-AH-79	
200571794	Tofu	Tofu-Demeter-80	organic
200571795	Tofu	Tofu-ProLaTerre-81	
200571796	Tofu	Tofu-Taifun-82	
200571797	Basil	Basilicum-AH-83	
200571798	Basil	Basilicum-Odin-84	organic
200571799	Basil	Basilicum-Jumbo-85	

Annex 3 Scope of analysis methods used for pesticide analysis

Method 1		
SOP		CHE01-WV660
SRM method for polar/anionic pesticides		
Pesticide/metabolite		LOQ (mg/kg)
1	Bromide	0.1
2	Chlorate	0.02-0.05
3	Ethephon	0.02
4	HEPA*	0.05-0.2
5	Fosetyl	0.02
6	Phosphonic acid	0.1-0.2
7	Glufosinate	0.02
8	N-acetyl-glufosinate	0.01-0.02
9	MPPA	0.01-0.05
10	Glyphosate	0.02-0.05
11	N-acetyl-glyphosate*	0.01-0.02
12	AMPA*	0.01-0.05
13	N-acetyl-AMPA*	0.01-0.02
14	Perchlorate	0.01-0.05

Method 2		
SOP		CHE01-WV643
Multi-method LC-MS/MS medium polar pesticides		
pesticide/metabolite		LOQ (mg/kg)
1	acetamiprid	0.01
2	ametoctradin	0.01
3	aminopyralid	0.01
4	amisulbrom	0.01
5	amitraz	0.01
6	asulam	0.01
7	azinphos-methyl	0.01
8	azoxystrobin	0.01
9	benthiocalicarb-isopropyl (R)	0.01
10	benthiocalicarb-isopropyl (S)	0.01
11	bifenazate	0.01
12	bitertanol	0.01
13	bixafen	0.01
14	boscalid	0.01
15	bupirimate	0.01
16	buprofezin	0.01
17	carbaryl	0.01
18	carbendazim	0.01
19	carbofuran	0.01
20	carbofuran, 3-hydroxy	0.01
21	chlorantraniliprole	0.01
22	chlorfenvinphos (2 isomers)	0.01
23	chlorprofam	0.01
24	chlorpyrifos	0.01
25	chlorpyrifos-methyl	0.01
26	chromafenozide	0.01
27	clofentezine	0.01
28	clopyralid	0.01
29	clothianidin	0.01

Method 2		
SOP		CHE01-WV643
Multi-method LC-MS/MS medium polar pesticides		
	pesticide/ metabolite	LOQ (mg/kg)
30	cyazofamid	0.01
31	cyflufenamid	0.01
32	cyflumetofen	0.01
33	cyproconazole (2 isomers)	0.01
34	cyprodinil	0.01
35	demeton-S-methyl sulfone	0.01
36	diazinon	0.01
37	dichlofluanid	0.01
38	dichlorvos	0.01
39	diethofencarb	0.01
40	difenoconazole (2 isomers)	0.01
41	dimethoate	0.01
42	dimethomorph (2 isomers)	0.01
43	diniconazole	0.01
44	dinotefuran	0.01
45	diuron	0.01
46	DMF (degr. amitraz)	0.01
47	DMPF (degr. amitraz)	0.01
48	DMSA (degr. dichlofluanid)	0.01
49	DMST (degr. tolylfluanid)	0.01
50	dodine	0.01
51	EPN	0.01
52	epoxiconazole	0.01
53	ethion	0.01
54	ethirimol	0.01
55	ethoprophos	0.01
56	etofenprox	0.01
57	etoxazole	0.01
58	famoxadone	0.01
59	fenamidone	0.01
60	fenarimol	0.01
61	fenazaquin	0.01
62	fenbuconazole	0.01
63	fenhexamid	0.01
64	fenoxycarb	0.01
65	fenpropimorph	0.01
66	fenpyroximate	0.01
67	fenthion	0.01
68	fenthion sulfoxide	0.01
69	fludioxonil	0.01
70	flufenoxuron	0.01
71	fluopyram	0.01
72	flusilazole	0.01
73	flutolanil	0.01
74	flutriafol	0.01
75	fluxapyroxad	0.01
76	furathiocarb	0.01
77	halofenozide	0.01
78	haloxyfop, free acid	0.01
79	hexaconazole	0.01
80	hexythiazox	0.01
81	hymexazool	0.01
82	imazalil	0.01
83	imazapic	0.01
84	imidacloprid	0.01

Method 2		
SOP		CHE01-WV643
Multi-method LC-MS/MS medium polar pesticides		
	pesticide/ metabolite	LOQ (mg/kg)
85	indoxacarb	0.01
86	iprovalicarb (2 isomers)	0.01
87	kresoxim-methyl	0.01
88	linuron	0.01
89	lufenuron	0.01
90	malathion	0.01
91	mepanipyrim	0.01
92	metalaxyl	0.01
93	methamidophos	0.01
94	methidathion	0.01
95	methiocarb	0.01
96	methiocarb sulfone	0.01
97	methiocarb sulfoxide	0.01
98	methomyl	0.01
99	methoxyfenozide	0.01
100	monocrotophos	0.01
101	myclobutanil	0.01
102	nitenpyram	0.01
103	omethoate	0.01
104	oxadixyl	0.01
105	oxamyl	0.01
106	oxamyl-oxime	0.01
107	oxydemeton methyl	0.01
108	penconazole	0.01
109	pencycuron	0.01
110	phenthoate	0.01
111	phosalon	0.01
112	phosmet	0.01
113	picolinafen	0.01
114	picoxystrobin	0.01
115	piperonyl butoxide	0.01
116	pirimicarb	0.01
117	pirimicarb, desmethyl	0.01
118	pirimiphos-methyl	0.01
119	prochloraz	0.01
120	profenofos	0.01
121	propamocarb	0.01
122	propargite	0.01
123	propiconazole	0.01
124	propyzamide	0.01
125	proquinazid	0.01
126	pymetrozine	0.01
127	pyraclostrobin	0.01
128	pyridaben	0.01
129	pyrimethanil	0.01
130	pyrimidifen	0.01
131	pyriproxyfen	0.01
132	quinoxifen	0.01
133	rotenon	0.01
134	silthiopham	0.01
135	spinetoram I+II	0.01
136	spinosad	0.01
137	spirodiclofen	0.01
138	spiromesifen	0.01
139	spirotetramat	0.01

Method 2		
SOP		CHE01-WV643
Multi-method LC-MS/MS medium polar pesticides		
	pesticide/metabolite	LOQ (mg/kg)
140	spiroxamine	0.01
141	tebuconazole	0.01
142	tebufenozide	0.01
143	tebufenpyrad	0.01
144	teflubenzuron	0.01
145	tembotrione	0.01
146	tetraconazole	0.01
147	thiabendazole	0.01
148	thiacloprid	0.01
149	thiamethoxam	0.01
150	thiophanate-methyl	0.01
151	tolclophos-methyl	0.01
152	tolyfluanid	0.01
153	triadimefon	0.01
154	triadimenol (A+B isomeer)	0.01
155	triazophos	0.01
156	triazoxide	0.01
157	trichlorphon	0.01
158	trifloxystrobin	0.01
159	triflumizole	0.01
160	zoxamide	0.01

Annex 4 Results of pesticide analysis

	Pesticide	Bromide	Chlorate	Glyphosate	Phosphonic acid	Azoxystrobin	Boscalid	Cyprodinil	Cyproconazole	Dimethomorph	Dodine	Famoxadone	Fluxapyroxad	Metaxyl	Penconazole	Propiconazole	Primethanil
Sample type	Remark	Concentration (mg/kg)*															
Agave syrup																	
Agave syrup																	
Agave syrup																	
Almond milk	organic	0,25															
Almond milk		0,36															
Almond milk		0,14	0,51		0,35												
Almond milk		0,25															
Almond milk		0,23															
Almond milk		0,14			0,36												
Peanut oil	organic																
Peanut oil																	
Raisins					7,86												
Raisins	organic																
Raisins					1,77	0,024	0,26	0,30		0,015		0,14	0,012	0,19	0,028		0,73
Cashew drink		0,12			0,044												
Cashew drink		0,46			0,064												
Macadamia nuts		1,76															
Macadamia nuts		4,73			10,4												
Dry apricot	organic																
Dry apricot					4,32						0,033						
Dry apricot	organic	14,5															

* Only pesticides with one or more residue values > LOQ are shown; all other samples were < LOQ for all pesticides

			Pyrimethanil	Propiconazole	Penconazole	Metaxyl	Fluxapyroxad	Famoxadone	Dodine	Dimethomorph	Cyproconazole	Cyprodinil	Boscalid	Azoxystrobin	Phosphonic acid	Glyphosate	Chlorate	Bromide	Pesticide
Sample type	Remark	Concentration (mg/kg)																	
Dry beans	organic	0,27																	
Dry beans	organic	0,26																	
Dry beans		1,53																	
Dry dates		2,30																	
Dry dates	organic	3,75																	
Dry dates	organic	3,05																	
Dry marrowfat peas	organic	6,10																	
Dry marrowfat peas	organic	3,44																	
Dry chickpeas	organic	2,92													0,43				
Dry chickpeas	organic	3,06													0,28				
Dry chickpeas		1,60																	
Dry chickpeas	organic	2,01																	
Lentils	organic	2,61																	
Lentils	organic	11,3																	
Lentils	organic	2,69																	
Lentils		4,64																	
Lentils	organic	4,10																	
Lentils	organic	3,46													0,65				
Lentils	organic	4,29													0,80				
Lentils	organic	2,25																	
Lentils	organic	2,34																	
Lentils	organic	2,81																	
Dry plums	organic																		
Dry plums															32,0				
Dry plums	organic																		
Dry figs	organic	6,26																	
Dry figs		5,37																	
Dry figs	organic	3,59																	
Oat flakes		1,13													0,43				
Oat flakes	organic	1,35																	
Oat flakes	organic	2,27																	
Oat flakes	organic	1,11																	
Oat flakes	organic	3,22																	
Oat flakes		0,67																	
Millet	organic	3,52																	

* Only pesticides with one or more residue values > LOQ are shown; all other samples were < LOQ for all pesticides

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