

Vegetables

Fact sheet

In this fact sheet, we take a look at the various kinds of vegetables, nutrients in vegetables and related health, food safety, behavioural and sustainability aspects.

Vegetables without added salt and sugar are part of the Wheel of Five. The recommendation for adults is to eat at least 250 grams of vegetables per day. Vegetable drinks, juices or smoothies, tinned vegetables or vegetable preserves with added salt or sugar are not included in the Wheel of Five.

Vegetables contain many nutrients and eating vegetables is related to a lower risk of chronic diseases. Eating enough vegetables helps to reduce the chance of contracting cardiovascular diseases, certain forms of cancer and type 2 diabetes. If you regularly select different vegetables, you can benefit optimally from the various nutrients in vegetables. Eating vegetables is not interchangeable with, and cannot be replaced by, taking a vitamin pill.

We eat around 85% of vegetables in our diet during the evening meal and 9% during lunch. Many people would benefit by often choosing to eat vegetables at other times than the evening meal.

In order to encourage people to eat enough vegetables, the food on offer could be presented in a way that makes it easier for people to choose vegetables. Making vegetables cheaper could also ensure that more vegetables are bought.

It is recommended that vegetables should always be washed thoroughly under running water to remove dirt and dust. Eating in-season vegetables is better for the environment than eating out-of-season vegetables that have been cultivated in gas-heated greenhouses or imported by air.



For whom is it relevant?

This fact sheet is relevant for, among others, nutrition professionals, nutrition scientists, dieticians, doctors, nurse practitioners, teachers, policymakers, supermarkets, crop growers and vegetable traders.

What issues are involved?

Vegetables are the edible parts of a plant. Vegetables without added salt and sugar are contained in the Wheel of Five. Vegetables include the following varieties:

- Leafy vegetables: spinach, endive, lettuce, lamb's lettuce, iceberg lettuce, turnip tops, purslane, chard, watercress.
- Vegetables that are botanically fruit: tomato, sweet pepper, courgette, cucumber, aubergine, pumpkin, sweetcorn, avocado*, artichoke.
- Tuberous plants: beetroot, carrot, celeriac, radish, winter carrot, turnip, salsify, parsnip, white radish.

- Cabbage varieties: broccoli, white cabbage, Brussels sprouts, cauliflower, kale, Chinese cabbage, kohlrabi, red cabbage, savoy cabbage, pointed cabbage, pak choi.
- Onion varieties: garlic, onion, scallion, leek.
- Stem vegetables: celery, fennel, asparagus, artichoke, rhubarb, bamboo.
- Sprout vegetables: bean sprout, garden cress.
- Other vegetables: pea**, garden bean**, chicory, green bean**, mushroom, button mushroom, mixed salad, mixed vegetables.

(Sweet) potatoes, other tuberous plants, legumes and vegetable juices are not included in the definition of vegetables due to their divergent nutritional values or their use.

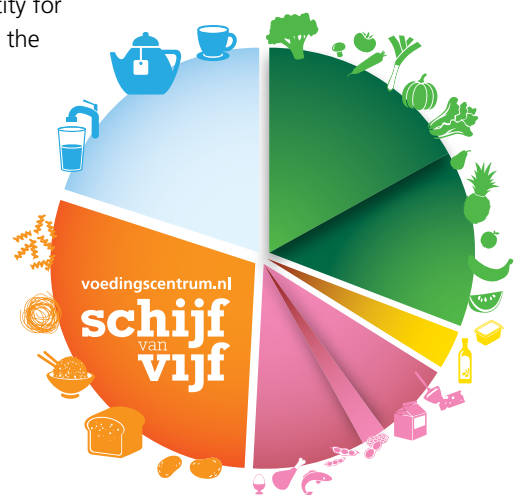
*Avocados diverge from other types of vegetables in terms of nutritional value, as they contain much more (but mostly unsaturated) fat.

**Botanically, these are legumes.

Recommended daily quantity

The Dutch Dietary Guidelines 2015, issued by the Health Council of the Netherlands, set out which foods and eating patterns lead to improved health.¹ The Netherlands Nutrition Centre has translated these guidelines into the Wheel of Five.² The recommended quantity for vegetable consumption in the Wheel of Five is slightly higher than the recommendation of the Health Council. This is because the Wheel of Five makes recommendations for total daily nutrition, thus also meeting energy and nutrient requirements.

Age	Recommended quantity for vegetable consumption in the Wheel of Five (grams)
1 - 3	50 - 100
4 - 8	100 - 150
9 - 13	150 - 200
14 - 18	250
>18	250



Vegetables within and outside the Wheel of Five

Included in the Wheel of Five

- Fresh vegetables
- Pre-cut vegetables
- Frozen vegetables without added sugar and salt
- Vegetables in tins or jars without added sugar or salt
- Pureed vegetables without added sugar or salt

Not included in the Wheel of Five*

- Vegetables in tins or jars with added sugar or salt
- Vegetable juice
- Creamed vegetables
- Soups with vegetables
- Vegetables processed in products that are not in the Wheel of Five

*Why not in the Wheel of Five?

- There is a sufficient choice of fresh vegetables, frozen vegetables and low-salt tinned vegetables to meet the guideline on vegetables.
- Vegetable juice is a sugary drink that contains less fibre and vitamin C. Drinking this type of beverage increases the chance of obesity and type 2 diabetes.
- Creamed vegetables contain added cream and salt. This makes them a less healthy choice.
- Soups often contain added salt or stock cubes.
- There is a sufficient choice of fresh or frozen vegetables to meet the guideline on vegetables.

Consumption of vegetables in the Netherlands

The latest Food Consumption Survey of the National Institute for Public Health and the Environment (RIVM) charts the eating habits of the Dutch population in the period 2012-2014.³ This data was compared with the recommendations contained in the Wheel of Five.⁴ The current consumption of vegetables is below the recommended quantity of 250 grams. On average, adults eat 139 grams of vegetables per day⁵, which is a little over half the recommended quantity. Vegetable consumption increases with age. Young children aged 1-3 score relatively well: they meet the lower limit for their age with an average of 52 grams per day. Men and women aged 51-79 also eat slightly more vegetables on average: 150 grams per day. Of all types of vegetables consumed, 91% are in the Wheel of Five. There is considerable variation in the percentage of the population that consumes at least the minimum

recommended quantity of vegetables. Among children aged 1-3, 44% eat at least the minimum recommended quantity of vegetables. Among adults aged 19-50, this figure is 3-4%. For the total population aged 1-79, the percentage is 6%.⁴ It should be noted that this does not include people who eat almost the recommended quantity, for instance 245 grams; 250 grams was the cut-off quantity.

Dutch consumers eat about 85% of their vegetables during the evening meal and 9% during lunch. Many people would benefit by more often choosing other moments than the evening meal to eat vegetables. Big vegetable eaters (=P95) eat almost the recommended quantity of vegetables (Figure 1).

Since 2012, the falling trend in vegetable consumption among young adults seems to have stopped.⁶

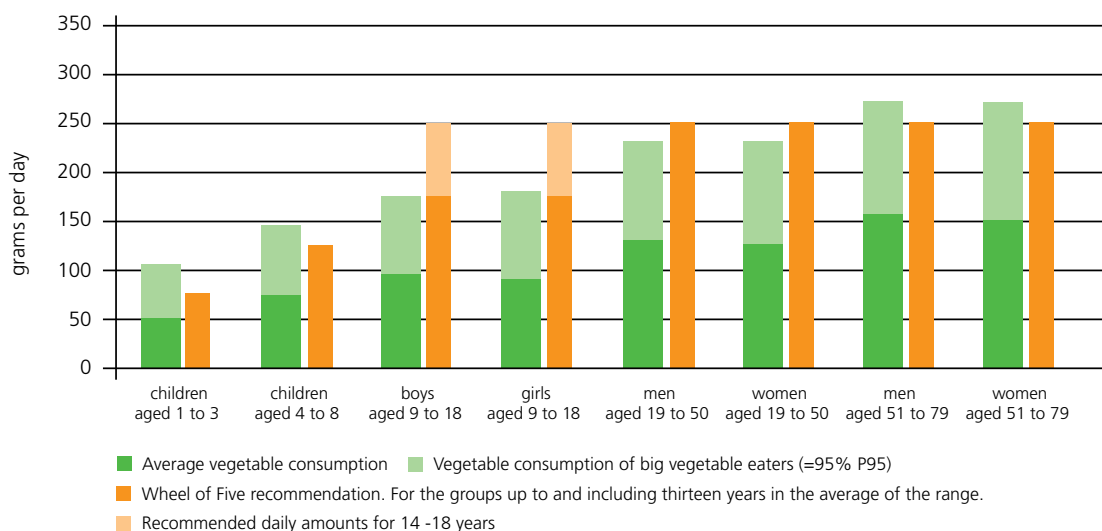


Figure 1. The vegetable consumption of people aged 1 to 79 in the Netherlands (number of persons =2,237).⁴ Both the average consumption of vegetables and the vegetable consumption of big vegetable eaters are indicated (=P95) and compared with the vegetable recommendation in the Wheel of Five.

Which vegetables do we eat the most?

The top 10 most frequently eaten vegetables on average among adults in the age category 19-69 are onions (7.1 g/day), tomatoes (6.9 g/day), cauliflower (6 g/day), green beans (5.5 g/day), carrots (5 g/day), broccoli (4.5 g/day), cucumbers (4.2 g/day), iceberg lettuce (3.4 g/day), chicory (3.3 g/day) and lettuce (2.5 g/day).⁷

Current scientific knowledge: health

If we look at the health effects of vegetables and fruit, the available intervention research uses varieties of both vegetables and fruit, thus not allowing the separate effects of vegetables and fruit to be determined. However, the cohort studies do examine the effects of vegetables and fruit separately.¹

For more information on various types of research, visit www.voedingscentrum.nl/voedingswetenschap.

Health benefits of vegetables

Eating vegetables and fruit reduces the risk of coronary heart disease and stroke.^{1,8} Eating a combination of vegetables and fruit reduces (systolic) blood pressure. Cohort studies have identified a relationship between vegetables and a lower risk of coronary heart disease and stroke.

In addition, cohort studies show a link between eating vegetables and a lower risk of intestinal cancer, and between high intake of leafy green vegetables and a reduced chance of type 2 diabetes and lung cancer. There is a possible link between a high intake of leafy green vegetables and a reduced chance of stroke.⁸

Nutrients

Vegetables provide important nutrients, such as vitamins, minerals and dietary fibre.⁹ Vegetables contain, among other things, vitamin C, vitamin A, folic acid, potassium, iron and calcium. Moreover, vegetables contain bioactive substances such as carotenoids and flavonoids. It is not clear which substances in vegetables provide protection against chronic diseases. This is probably due to the various combinations of vitamins, minerals, fibres and other substances in vegetables.¹⁰ Vitamin deficiencies can also lead to illnesses. It is known that vitamin C (from vegetables and fruit) protects against scurvy and anaemia.^{11, 12}

The quantities of nutrients vary between the various kinds of vegetables.⁹ There can even be differences in the quantity of nutrients between different specimens of the same vegetable. The quantities of nutrients can vary depending on the variety, the season, the soil, the use of fertilisers and climate.¹³ There is no clear evidence that organically grown vegetables contain more nutrients than vegetables from non-organic cultivation.¹⁴ Vegetables from tins or jars and frozen vegetables contain just as many nutrients as unprocessed fresh vegetables.^{9, 15, 16}

Vegetables are not fruit

Since vegetables and fruit vary in terms of nutrients, the Netherlands Nutrition Centre advises eating both 250 grams of vegetables and 200 grams of fruit each day. Vegetable types also differ from each other in their quantity of nutrients. Therefore, the advice is to eat

plenty of different types of vegetables. This ensures that you consume as many different nutrients as possible.

Multivitamins

Vegetables cannot be replaced by a multivitamin pill or supplement.¹⁷ A healthy eating pattern in line with the Wheel of Five provides you with enough nutrients.^{1,2} Some groups, such as pregnant women and elderly people, or people who do not spend much time outdoors, require certain nutritional supplements. Read more about this in the fact sheet 'Recommendations for vitamins, minerals and trace elements' at www.voedingscentrum.nl/factsheets.¹⁸

Effects of preparation methods on nutrients in vegetables

The method used to prepare vegetables has an effect on how many nutrients the body absorbs from these. Nutrients are ingested more easily by the body from cooked or prepared vegetables. Alternating between raw vegetables and prepared vegetables and varying the types of vegetables consumed will ensure that you are provided with enough nutrients.

Pre-cut vegetables may contain less vitamin C than uncut vegetables. Vitamin C is lost during the peeling and cutting due to the effect of oxygen.¹⁹ The loss of vitamin C remains limited if the pre-cut vegetables are packaged under low-oxygen conditions (protected atmosphere). Vegetables lose between 20 and 50% of their vitamins during boiling; the vitamins end up in the water used for boiling.²⁰



With respect to the loss of minerals, it is likewise recommended that vegetables be boiled for no longer than necessary in a small amount of water.²¹ Steaming and stir-frying are methods that retain the highest quantity of the vitamins. It is advisable to briefly warm vegetables from tins or jars before the water boils. Frozen vegetables should be boiled with a small amount of water according to the instructions on the pack.

Nutrients then and now

Information about the differences in quantities of nutrients in vegetables in earlier times and today can be obtained from foodstuffs charts such as the Dutch Food Composition Database (NEVO).⁹ NEVO presents data about the composition of foodstuffs that are regularly consumed in the Netherlands. There are indications that some vegetables contain fewer minerals than was previously the case.²² This difference may partly be due to a difference in measuring methods. Moreover, there is often variation in the quantity of minerals between different specimens of the same vegetable. By comparison, the differences between earlier times and now are virtually negligible.¹³

Current scientific knowledge: food safety

It is important to handle vegetables in line with food safety principles. This can be done by washing vegetables well and also by varying the kinds of vegetables you eat.

Bacteria and viruses

Pathogenic bacteria or viruses, such as salmonella and E. coli, can occur on vegetables through external contamination.²³ These can cause a food-borne infection. Although it is not possible to wash off all bacteria, it remains important always to carefully wash vegetables under running water. This also removes dirt and dust. It is preferable to throw away mouldy vegetables, because mould toxins may be present.

Pesticides

Residues of pesticides may remain on and in vegetables. There is only a very small chance that such pesticide residues present a danger to health. The Netherlands Food and Consumer Product Safety Authority (NVWA) checks thousands of samples each year to see whether any residues found on or in vegetables exceed the legal limits. The vast majority of these products meet the legal requirements.²⁴ The number of cases where limits are exceeded is low and even in these cases, the risk remains far below the safety level for public health. The positive effects of vegetables are far greater than these possible risks. Fewer pesticides are used for organic vegetables. The agents that are used are of natural origin and are

better for the environment. Read more about this in the fact sheet 'Bestrijdingsmiddelen en voeding' (in Dutch) at www.voedingscentrum.nl/factsheets.²⁵

Nitrate

Nitrate is a substance that naturally occurs in vegetables such as lettuce, spinach and beetroot. During preparation or storage of these vegetables, nitrate can be converted into nitrite and under certain circumstances may be converted into carcinogenic nitrosamines. Research shows that eating nitrate-rich vegetables poses a negligible risk to health.²⁶ This is why there are no limiting recommendations with regard to eating nitrate-rich vegetables.

Harmful substances

Harmful substances may be found on and in vegetables. This can involve contaminants such as heavy metals that can end up in our vegetables through the environment. Some vegetables naturally contain small quantities of toxins as protection against natural enemies. These amounts are so small that they do not pose any risks to health. By eating a varied diet, you can avoid ingesting too much of any harmful substance and the health risk posed by possible harmful substances is in any case very small or negligible.⁶

Current scientific knowledge: sustainability

The vegetables chain can be divided into a fresh chain and a processing chain. In the production sector, we distinguish between greenhouse cultivation and outdoor cultivation.²⁷ The environmental pressure of vegetables per kilo is comparable to other plant product groups such as cereals, legumes and bread.²⁸ The cultivation, transport and processing aspects have the highest environmental impact. Vegetables cultivated outdoors are usually better for the environment than vegetables from a gas-heated greenhouse.

Due to the processing involved, frozen and preserved vegetables have a slightly higher environmental impact than fresh outdoor products, but lower than imports or greenhouse products. Heating and lighting in greenhouse cultivation consumes a lot of energy, especially in winter. Fresh vegetables from European outdoor cultivation put the lowest level of pressure on the environment.²⁹ In the Netherlands, one-fifth of vegetables are grown outdoors and two-thirds come from greenhouses. The rest is imported. Importing by air creates a particularly high environmental pressure, but this involves only a very small part of the supply.³⁰ It is mandatory that the land of origin is stated on fresh and packaged vegetables. This does not apply to processed vegetables.

Environmental impact per vegetable type from low to high (greenhouse-gas emissions)²⁸:

1. Onions and onion varieties
2. Stem vegetables
3. Tuberous plants
4. Leaf vegetables
5. Cabbage types from outdoor cultivation
6. Peas and garden beans
7. Vegetables that are botanically fruit

Milieu Centraal, a public advisory body, has produced a vegetables and fruit calendar which shows at a glance under which environmental category (A to E) a product falls. The category is based on the quantity of fossil energy, agricultural land and greenhouse gases that were involved in getting a product into the shop in a certain month.³¹

Less waste

Vegetables are in the top five of the most-wasted products.³² The best approach is to eat them as soon

as possible after harvesting. This is because harvested vegetables remain a living product, and their composition changes even in the first few hours after the harvest and then during storage and preparation.³³

Good storage helps to prevent waste. The best thing for most vegetables is to keep them in their packaging in the refrigerator, but there are exceptions, such as vegetables that are botanically fruit and winter carrots. Tinned vegetables are better stored after opening in a closed storage box in the refrigerator instead of in the original can, because otherwise the quality deteriorates due to oxygen exposure.

Some types of vegetables are sensitive to ethylene, a natural substance produced by tomatoes and certain types of fruit.³⁴ We therefore make specific recommendations for a longer shelf life (see Figure 2). Ethylene production is significantly reduced under refrigerated conditions (<4 °C)..

		Ethylene-sensitive		
		Hoog	Midden	Laag
Ethylene-producing	High	Apples, kiwis, pears	Avocados, melons, passion fruits	
	Medium	Apricots, bananas, mangoes	Nectarines, papayas, peaches, plums, tomatoes	
	Low	Cabbage types, carrots, cucumbers, lettuce, potatoes	Asparagus, celery, citrus fruits, aubergines	Artichoke, berries, cherries, grapes, pineapple, sweet peppers

Green: can be stored with all other products
Pink: do not store with orange and yellow
Orange: accelerates ripening for orange and yellow

Figure 2. Types of vegetables and fruit that produce ethylene and are sensitive to ethylene



Quality marks

Independent quality marks indicate how vegetables are cultivated. The quality marks you will find on vegetables are: Milieukeur, European quality mark for organic agriculture, EKO quality mark, Demeter and Fairtrade/Max Havelaar. In 2019, Milieukeur will be replaced for plant products by 'On the way to PlanetProof'.



Current scientific knowledge: behaviour

In order to reach the recommended quantity for vegetables in the Wheel of Five, the Dutch should on average eat almost twice the amount of vegetables per day than they do now. There are various methods for achieving this.

Make it easier to eat more vegetables

More vegetables could be eaten during the evening meal. Encouraging people to eat vegetables at various times of the day could also help to increase vegetable consumption. This could include snack vegetables at school or at work, sweet pepper strips on bread, salads with lunch, vegetable leftovers in an omelette for lunch or carrots as a snack on the go.

Vegetable Meter

We have developed the Vegetable Meter for people who want to eat more vegetables. This shows you how many vegetables you eat in a day and you receive immediate customised tips about how to eat more vegetables at various moments of the day. Visit www.voedingscentrum.nl/groentemeter

People can make it easier for themselves by, for instance, buying different kinds of vegetables and also cooking several types of vegetables for a meal.^{35,36} It could also be helpful to store vegetables more visibly, for instance snack tomatoes in the fruit bowl to take as you go past.^{37, 38}

Healthier environment

Parties that are responsible for the food supply, such as parties that sell foodstuffs and policymakers concerned with shaping the environment, could contribute to an increased consumption of vegetables. They could exert influence through the municipal location policy. Suppliers could present their food offering in such a

way that people choose vegetables more easily. Food that is present in large quantities and easily visible, and is easier to take, will be chosen more quickly. In (school) canteens and company restaurants, this could be achieved, for instance, by placing vegetables prominently and at the front.^{39,40} Restaurants could present vegetables more centrally, make vegetable portions bigger and increase the proportion of vegetables in dishes.⁴¹⁻⁴³ Suppliers of on-the-go snacks could tempt people to choose vegetables as a snack on the go, for instance by offering snack vegetables and positioning these prominently.

Make vegetables cheaper

The consumption of vegetables could also be encouraged by making vegetables cheaper, for instance by means of subsidies or tax measures. The price of foodstuffs plays a role in the quantities of those that we buy. It has been established that a price reduction of 10% for vegetables would lead people to buy about 5% more vegetables.⁴⁴ This does not mean that everyone will automatically buy more vegetables if they are cheaper. Aside from price, this involves many other factors, such as the availability of alternative foodstuffs and what part of our income we spend on food.⁴⁵ In other countries, this share is larger than in the Netherlands.⁴⁶ It is logical that in a country where a relatively small amount of income is devoted to food, price measures will have smaller effects.

Looking to the future

The goal of reducing salt levels in products such as tinned vegetables is a positive development that is supported, and closely monitored, by the Netherlands Nutrition Centre. In the field of food safety, it will continue to track the NVWA's screening for pesticide residues in products and monitor new research that might prompt it to adjust its standpoint.

The Netherlands Nutrition Centre advocates the creation of an environment in which eating vegetables is encouraged. This is an important task for policy-makers, schools, (company) restaurants and other food suppliers.

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