



Vegetables in the daily diet: Nutritional effects

"Then said Daniel to Melzar, whom the prince of the eunuchs had set over Daniel, Hananiah, Mishael, and Azariah, "Prove thy servants, I beseech thee, ten days; and let them give us pulse to eat, and water to drink. Then let our countenances be looked upon before thee, and the countenance of the children that eat of the portion of the king's meat: and as thou seest, deal with thy servants." So he consented to them in this matter, and proved them ten days. And at the end of ten days their countenances appeared fairer and fatter in flesh than all the children which did eat the portion of the king's meat."

Daniel, 1:12-16
(King James Version)

Two and a half millennia after this Biblical test of the effects of two very different dietary philosophies, progress in medicine has led scientific thought to a consensus regarding the undeniable value of vegetable consumption for human health.

In English, the term “vegetable” has come to designate a wide range of edible plant materials covering the entire botanical repertoire: leaves, roots, fruits, stems, seeds, flowers and other structures that humans have adopted, adapted, cultivated or laboured for consumption as food.

The vast majority of human populations consume vegetables, the notable exception being the inhabitants of arctic regions, at least before the introduction of vegetables processed by methods allowing their preservation.

Vegetables represent a major portion of our diet, both quantitatively and qualitatively. Three to four hundred grams per day are recommended for adults and variety is strongly recommended, since in addition to providing a wide range of taste sensations, different vegetables represent very different nutritional assets, depending on their type, colour and size. Mineral and vitamin contents may vary by a factor of ten and certain valuable substances are peculiar to specific varieties or strains within a vegetable species.

Vegetables: a source of water

The principal characteristic of vegetables is their high water content, which is usually in the 85-95% range (mass basis), except for corn and peas, which are closer to 75% water. [Data from Ciqual (*Centre d'information sur la qualité des aliments*), AFSSA]

Daily intake of water comes from drinking water (about 1.5 litres per day) and from water contained in foods (about 1 litre per day). Consumption of 300 g of vegetables per day is equivalent to 270 ml of water or about 27% of the non-drink daily intake.

This characteristic makes vegetables relatively low-calorie foods. Their caloric content comes mostly from carbohydrates and ranges anywhere from 15 to 60 kcal per 100 g or about 50 to 200 kcal from the daily consumption of 300 g.

Their high water content makes vegetables sensitive to drying out as well as to the growth of microbes, which can spoil them within a few days, making the quality of storage conditions a major factor in vegetable consumption and necessitating either rapid post-harvest consumption or rapid processing to storable products.

The remainder of the vegetable mass consists mostly of fibre, minerals, vitamins and antioxidants.

Vegetables and vitamins:

Vitamins are essential for acquiring and maintaining good health. A few of the 13 vitamins known today are found primarily in the plant kingdom and in particular in vegetables:

Vitamin A helps maintain good vision, especially night vision, in addition to healthy skin and mucous membranes as well as growth. It is a fat-soluble vitamin widespread in the plant kingdom in the form of pro-vitamin A or beta-carotene. Other carotenoids, such as lutein and lycopene are also found in vegetables. These are considered nutritionally valuable as antioxidants.

Pro-vitamin A has the advantage of not contributing to vitamin A toxicity. When the body has accumulated sufficient vitamin A, pro-vitamin A is no longer converted to vitamin A and thus is not toxic. Recommended dietary intake is one third vitamin A (as retinol, found in products of animal origin) and two-thirds pro-vitamin A.

The vegetables richest in pro-vitamin A:

Yellow-orange vegetables, notably carrots, red bell peppers, tomatoes, pumpkin
Green vegetables, notably spinach, lettuce, watercress, mache (lamb's lettuce), sorrel, broccoli, parsley

Half of the recommended daily intake is reached with 70 g of red bell pepper, 60 g of spinach, or 50 g of lamb's lettuce.

Vitamin E (α -tocopherol) contributes to reducing oxidative damage to tissues (i.e. as an antioxidant). It is also a factor in certain fertility problems. This fat-soluble vitamin is present in significant quantities in vegetables in spite of their relatively low lipid content.

The vegetables richest in vitamin E:
Spinach, asparagus, watercress, fennel

Half of the recommended daily intake is reached with 100 g of fennel or with 200 g of spinach seasoned with oil.

Vitamin C, also known as ascorbic acid, is a water-soluble antioxidant. It participates in iron absorption and helps the body fight off infections. It is found specifically in fruits and vegetables, the latter being the principal source in our daily diet.

This vitamin is not stored in the body and must therefore be ingested daily with the various meals and snacks.

The vegetables richest in vitamin C:

Carrots, cabbages (especially Brussels sprouts), watercress, spinach, lamb's lettuce, sorrel, peas and bell peppers are all good sources of vitamin C.

The recommended daily intake is reached with 50 g of green pepper, 100 g of Brussels sprouts, 100 g of broccoli or 150 g of spinach or cauliflower.

Vitamin B9 (folic acid), important for women of childbearing age, protects against malformations of the neural tube during foetal development. It also plays a role in cell division.

In some countries, systematic supplementation of basic foodstuffs such as wheat flour has brought spectacular decreases in the frequency of neural tube malformations in newborns.

The vegetables richest in vitamin B9 are watercress, spinach, lamb's lettuce, Brussels sprouts, chickpeas, leek, sorrel, cauliflower, broccoli and asparagus.

The recommended daily intake is reached with 150 g spinach, 200 g of broccoli, or 200 g of chickpeas.

Certain vegetables such as green beans are not particularly rich in any of these vitamins. However, typical portions (e.g. 200 g) may contain over 30% of the recommended daily intake of vitamins A, C and B9. These vegetables are well balanced in terms of vitamin content, in addition to being widely available and easy to prepare and include in meals.

The mineral content of vegetables:

The various minerals each play numerous roles in the body, ranging from structural (calcium and phosphorus) to antioxidant (zinc and selenium) and including functions as activators of enzymes and in oxygen transport.

Vegetables make substantial contributions to the daily dietary intake of minerals, even though they are not the richest sources.

Calcium is a fundamental element of bones and teeth. Vegetables are the second provider of dietary calcium after dairy products and may contribute 10 to 30% of the daily requirement. This contribution should not be overlooked, especially in the case of children who have difficulty consuming dairy products in sufficient quantity, as well as among the elderly.

The natural presence of organic acids, ergosterol or phyto-oestrogens in vegetables favours the utilization of calcium in the body.

Calcium is found in parsley, spinach, cabbage, black radish, beets, broccoli, watercress, celery, green string beans, dandelion, purslane, salsify, artichoke, palm heart and sorrel.

Iron participates in the transport of oxygen to muscles. It is found in spinach, peas and especially in dried vegetables: lentils, chickpeas, dried beans. Vitamin C increases the efficiency with which iron is absorbed into the body. Organic acids present in certain vegetables also favour iron bioavailability.

Magnesium is necessary for the activation of numerous enzymes. It is present in spinach, peas, black radish and dried vegetables, in particular dried beans.

The vegetable richest in vitamins and minerals overall is spinach. This vegetable has a remarkable nutrient density.

Vegetable fibre:

The biggest contribution of vegetables to the daily diet is fibre. In fact, it was long believed that fibre was the only significant contribution of vegetables to the nutritional value of the daily diet. Of course, it is now known that this is far from the case.

Fibre has well known effects on intestinal transit. Two mechanisms of action come into play, depending on the type of fibre. Insoluble fibre absorbs water and increases faecal volume, which stimulates intestinal peristalsis, while soluble fibre forms a gel at the surface of the intestinal wall, also favouring the movement of faecal matter.

Soluble fibre also has beneficial effects on the health of the intestinal mucosa. It is a carbon source for intestinal bacteria; it captures bile salts and cholesterol and blocks the absorption of harmful substances across the intestinal epithelium. This effect is believed to provide protection against colorectal cancer. However, the same effect may also be involved in slowing down the absorption of some valuable nutrients into the body. The recommended daily consumption of fibre is 25 to 30 g per day, or about 17 g per day in Europe.

Vegetable sources of dietary fibre:

2 to 5 g per 100 g: eggplant, broccoli, carrots, mushrooms, chanterelle, Brussels sprouts, other cabbages, cauliflower, watercress, celery, endive, spinach, fennel, green string beans, turnip, dandelion, leek, bell pepper, pumpkin

5 to 10 g per 100 g: artichoke, peas, salsify, Jerusalem artichoke, white beans, black beans, kidney beans, lentils, chickpeas

Antioxidant compounds in vegetables:

Certain vitamins and minerals are believed to have antioxidant effects: vitamin E, vitamin C, zinc and selenium. Other plant-derived molecules also participate in these activities. These include polyphenolic compounds. This family is made up of primarily the following substances:

- Anthocyanins, natural colorants in red-violet vegetables (e.g. red onions, red cabbage),
- Flavones, in cabbage and onions
- Phyto-oestrogens, found in practically all vegetables

- Tannins, particularly in mushrooms (produced by enzymatic browning)

The beneficial effect of antioxidants is believed due to their ability to trap free radicals and thereby protect body tissues from damage caused by excessive oxidation, thus slowing down aging. Regular consumption of vegetables in sufficient quantity (at least 300 g per day for adults) as well as fruits (which are also rich in antioxidants) provides adequate intake of antioxidants. Research has shown that antioxidants are more effective when consumed in their natural association with foods than when taken as supplements. In fact, the myriad reactions associated with their effects are enhanced by the food nutrient content as a whole.

Recommended daily allowance for some vitamins and minerals and RDA coverage by vegetables; other dietary sources

Nutrient	RDA for adults	RDA coverable with recommended consumption of vegetables	Other dietary sources
Vitamin C	110 mg	50 to 100%	Fruits
Vitamin E	12 mg	20%	Oils, fruits
Vitamin B9	300/330 µg	50%	Meat, fruits
Beta-carotene	3600/4800 µg	50 to 100%	Fruits, butter, eggs
Calcium	900 mg	10 to 30%	Dairy products, mineral water
Iron	9/16 mg	30 to 50%	Meat, fish, grains

The role of vegetables in disease prevention:

Site of action	Beneficial effect
Digestive system	Accelerating intestinal transit and colonic fermentation, eliminating cholesterol, trapping bile salts, equalizing nutrient absorption throughout the intestine, preventing certain types of cancer
Liver	Better vitamin status; detoxifying activities
Circulatory system	Lowering blood pressure, decreasing platelet aggregation, protecting lipoproteins (cardiovascular disease)
General status	Increasing mineral and micronutrient availability,

	antioxidant protection
Metabolism	Decreasing caloric intake, improving responsiveness to insulin and resistance to weight gain
Acid-base equilibrium	Maintaining alkalinizing capacity
Kidney function	Improving calcium solubility (citrate), decreasing blood calcium, increasing urine pH
Bones	Calcium retention, phyto-oestrogen effects
Eyes	Slowing of macular degeneration, improvement of night vision (effects of carotenoids)
Skin	Slowing of aging by antioxidants; protective effects of carotenoids (against sunlight)

(Based on C. Rémésy, CR Acad. Agric. Fr., 2001, 87)

A varied diet, including at least five portions of fruits and vegetables per day, is indispensable for acquiring and maintaining good health. It is primarily the non-caloric fraction of these foods that provides the health benefits. Fibre, minerals, vitamins and antioxidant substances are at the principal contributors to the nutritional value of vegetables.