Fresh fruit and vegetables as health foods in the human diet

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What are fruit and vegetables?

Fruit and vegetables are the pre-eminent nutritious foods in the human diet. A large number of studies have shown that they are "health foods" which help prevent disease and improve health.

Today, in fact, fruit and vegetables are the only "health foods" with proven benefits for human health.

The Código Alimentario Español, Spanish dietary code or "CAE", defines fruit as "fruit, infructescences or the fleshy portions of floral organs that have achieved an appropriate degree of maturity and are fit for human consumption" [(1)].

CAE defines a vegetable as "any cultivated herbaceous plant in season that can be used for food, whether raw or in cooked form." Strictly, it defines vegetables as the edible green organs of a plant (leaves, stalks and inflorescences) [(1)]. Vegetables so defined are properly called hortalizas in Spanish, but the use of the term verduras is so widespread as to have become standard.

Vegetables are 75 to 95% water and low-calorie (20-40 kcal per 100 g of food). They have very low protein and fat contents of 1 to 4% and 0.5 to 0.6%, respectively. Vegetables provide variable amounts of carbohydrates (3 to 20%), especially simple carbohydrates, which can make up 1 to 6% [(2, 15)]. Water accounts for up to 80 to 90% of the weight of fruit; as in vegetables, protein and fat content is very low, except in avocado, where monounsaturated fat in the form of oleic acid makes up 16%. Up to 10% of fruit is made up of simple, rapidly absorbed sugars, except banana and grape (15-20%), which are very sweet and contain more calories than vegetables [(2, 15)]. Simple sugar content in fruit varies with the degree of ripeness – and hence with

the time of harvest. Sugar content is higher in riper fruit.

The nutritional value of fruit and vegetables lies mostly in their micronutrient content, their fibre content and their non-nutritional bioactive substances, such as vegetable phytochemicals and bioactive compounds. Many vegetables contain provitamin A in the form of beta-carotenoids (a natural colouring that lends a yellow, orange or reddish hue, also present in green vegetables but masked by chlorophyll), vitamin C and several B vitamins, notably folic acid. Fruit is generally higher-calorie than vegetables, contains a large quantity of vitamins, such as C (citrus fruit, tropical fruit, melon and strawberries), provitamin A in the form of betacarotenoids (melon, apricot, peach, nectarine, khaki, mango, persimmon, berries), and, to a lesser extent, B group vitamins [2, 15].

Almost all the vitamin C in our diet comes from fruit and vegetables. Light, mechanical shocks, exposure to atmospheric oxygen, prolonged storage, washing and the application of heat and water in cooking destroy up to 50 to 60% of vitamin content [2].

Fruit and vegetables also contain minerals such as potassium, magnesium and, less importantly, iron and calcium, which are hard for the body to absorb and use.

Fruit, vegetables and other plant-based foods are the main sources of fibre in the diet. It is now known that “dietary fibre” (formerly called “crude fibre”) comprises non-starch polysaccharides or NSPs (mainly cellulose, hemicellulose, pectins, gums and mucilages), lignin, oligosaccharides and resistant starches in varying combinations and proportions. The health benefits of dietary fibre - especially pectins - have been widely demonstrated in research. The water-retention capacity of fibre adds bulk to the faecal bolus, solidifies faeces, aids bowel

movement and brings beneficial physiological effects, such as improved glucose tolerance, lowering of total and LDL blood cholesterol levels and prevention of some forms of cancer, particularly colon cancer.

Recent research has focused on a specific type of oligosaccharides: fructo-oligosaccharides or FOS. These are short chains of fructose linked by 2-1 b-glucosidic bonds with a terminal D-glucosyl unit linked by an alpha-1-2 bond, present in some cereals and vegetables (including asparagus and onion). FOS are non-digestible carbohydrates, because the human intestine lacks enzymes capable of breaking down its bonds. This chemical feature lends FOS attractive physiological properties, such as low caloric value (about 2 kcal per g), sweetness, low capacity for causing caries, and effects similar to those of dietary fibre. They are viewed as prebiotics for their ability to modify colon flora by fostering the selective growth of groups or individual species of bacteria that discourage the settlement of pathogenic bacteria; in addition, FOS fermentation acidifies the environment, thus reducing carcinogen production [2].

All fruit and vegetables contain non-nutritional bioactive substances (many of which are responsible for the characteristic pigmentation of a given fruit or vegetable) with proven health benefits. Notable among these compounds – known as phytochemicals owing to their plant origin – are certain carotenoids, such as lycopene, a red pigment mainly present in tomato, red pepper and watermelon and thought to be a powerful antioxidant that helps prevent prostate cancer, or zeaxanthines, especially lutein in green-leaf vegetables, with its widely demonstrated role in the prevention of macular degeneration [16, 17].

Phenols are an important and complex group of phytochemicals that com-

prises flavonoids, catechines and anthocyanines. The most significant are anthocyanines (present in red onion, red grapes, strawberries, pomegranates, blackberries, plums and cranberries), quercetin (grapes, onion, broccoli, apples) and elagic acid. Health benefits include antihistamine, anti-inflammatory, diuretic and – especially – antioxidant properties, and their proven preventive role in cancer processes [18, 19, 20].

Also important are indoles and isocyanates, present in cruciferous vegetables (broccoli, cauliflower and cabbages), which help prevent cancer; the antioxidant resveratrol in grapes and grape by-products; and organic sulphurs, which help prevent cancer and heart disease, present in garlic and onions.

Fruit and vegetables also contain organic acids responsible for their smell and taste, such as citric acid (present in a wide variety of fruit and vegetables),

tartaric acid (grapes) and malic acid (apples). Other substances present in some leafy vegetables can act as anti-nutrients, such as oxalic acid, which has a chelating effect on the absorption of divalent minerals, including iron and calcium [2, 15].

Fruit and vegetables are thus complex foods that provide significant quantities of carbohydrates (especially sugars), low quantities of protein and fat, and are essential in the human diet. They provide water, dietary fibre, numerous vitamins and minerals and bioactive substances with major health benefits.

Fruit and vegetables: aspects of their dietary role

Fruit and vegetable consumption is essential to varied and nutritious diet. But World Health Organization data shows that fruit and vegetable consumption is low in many areas of the world[3].

Table 1

Availability of vegetables per capita, by region, 1979 and 2000 (kg per person per annum)

Region	1979	2000
World	66,1	101,9
Developed countries	107,4	112,8
Developing countries	51,1	98,8
Africa	45,4	52,1
North and Central America	88,7	98,3
South America	43,2	47,8
Asia	56,6	116,2
Europa	110,9	112,5
Australasia	71,8	98,7

Only a minority of the world population consumes the quantity recommended by the FAO and WHO. The worldwide trend toward city-dwelling has driven people away from the production of primary foods. This hinders the consumption of a varied, nutritious diet with an adequate proportion of fruit and vegetables. The poorest city-dwellers are not only remote from primary food production, they also find it harder to access healthy, varied diets. On the other hand, increased urban dwelling may support other aims, because people with enough purchasing power have wider access to a varied, nutritious and healthy diet.

World food production trends and the availability of fruit and vegetables indicate that present output and consumption differ greatly from region to region, as shown in table 1. These production statistics do not include wild and native vegetable output. Consumption may be underestimated, therefore[4].

In 2000 the average availability of vegetables per person worldwide was 102 kg per annum. The highest figure was recorded in Asia (116 kg), while the lowest were recorded in South America (48 kg) and Africa (52 kg). In Europe, the availability of vegetables per capita in 2000 was 112.5 kg[4].

In Spain in 2004, per capita consumption of fresh fruit and vegetables was 68.2 kg and 102.3 kg, respectively. These figures reflected a rising trend, with fruit and vegetable consumption increasing 5.4% and 4.7%, respectively[4].

Nutrient intake: the role of fruit, vegetables, dietary fibre and non-starch polysaccharides (NSPs)

FAO/WHO targets for nutrient intake are shown in table 2. Recommended intake is at least 400 g of fruit and vegetables per day. Wholegrain cereals, fruit and vegetables are the main sources of non-starch polysaccharides (NSPs), with consumption of these three foods providing in excess of the daily recommended intake of 20 g of NSP (> 25 g total dietary fibre)[4].

These intake bands consider fruit and vegetables for their energy value rather than their nutrient content. This approach takes account of the fact that the health benefits of fruit and vegetables cannot be attributed to a sole nutrient or mix of nutrients and bioactive substances, but to fruit and vegetable consumption as a whole. Hence fruit and vegetables are listed as a food category, instead of the individual nutrients. Tubers (e.g., potato, sweet potato and manioc) should not be included among fruit and vegetables[4].

Recommendations on total fat intake consider countries where intake is com-

Table 2

Nutrient intake bands

Food factor	Target (% total energy, unless otherwise indicated)
Total fats	15% - 30%
Saturated fatty acids	< 10%
Polyunsaturated fatty acids	6% - 10%
Polyunsaturated n-6 fatty acids	5% - 8%
Polyunsaturated n-3 fatty acids	1% - 2%
Trans fatty acids	< 1%
Monounsaturated fatty acids	Difference [A]
Total carbohydrates	55% - 75% [B]
Free sugars [C]	< 10%
Protein	10% - 15%
Cholesterol	< 300 mg per day
Sodium chloride (sodium)	< 5 g per day (<2 g per day)
Fruit and vegetables	≥ 400 g per day
Total dietary fibre	25 g per day
Non-starch polysaccharides (NSPs)	20 g per day

(a) Calculated as follows: total fats – (saturated fatty acids + polyunsaturated fatty acids + trans fatty acids).
(b) Percentage of total available energy after taking account of energy consumed in the form of protein and fat, hence the width of the band.
(c) "Free sugars" refers to all monosaccharides and disaccharides added to foods by manufacturers, cooks or consumers, plus sugars naturally present in honey, syrups and fruit juices.

monly high (above 30%) or very low (below 15%). An intake of at least 20% total fat in the diet is compatible with good health. In countries with a highly active population and a diet rich in fruit, vegetables, pulses and wholegrain cereals, total fat intake can be up to 35% without risk of harmful weight gain[4].

High intake of simple sugars detracts from the nutritional quality of the diet, because it provides energy lacking in nutrients to the detriment of other foods of higher nutritional quality. After drinking a very sugary drink, in fact, it has been shown that the compensating reduction in food intake is less than for other foods of the same energy content[5].

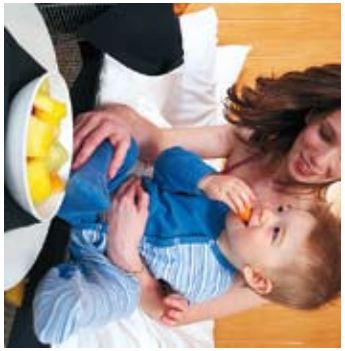
Fresh fruit and vegetables as health foods: role in prevention and health improvement

According to the WHO, present health trends focus on attaining the highest potential state of health over a person's lifetime, with prevention and health promotion taking priority over cure, along with improvement of the healthcare system, especially at the primary care level[6].

The underlying mechanisms of many chronic diseases are now better understood, and mitigating interventions have reduced the risk of suffering such diseases. There is now enough epidemiological evidence with regard to the diet/health relationship to identify risk factors for the most prevalent diseases and the dietary components that raise the likelihood of suffering or avoiding disease[4].

According to the WHO, the ten greatest health risks are:

- unprotected sex,
- high blood pressure,
- smoking,
- alcohol,
- defective water supply and sanitation,
- high cholesterol,
- solid fuel fumes in indoor



environments,
- iron deficiency,
- obesity, and
- being overweight.

These factors cause 40% of the 56 million deaths recorded worldwide every year. Of the world's 10 main causes of death, six are directly linked to the human diet[7].

The WHO and the United Nations Food and Agriculture Organization (FAO) recommend a minimum daily intake of 400 g of fruit and vegetables. But recent WHO data show that close to 2.6 million deaths worldwide in 2000 and 31% of cardiovascular diseases can be ascribed to insufficient fruit and vegetable intake[8].

According to that paper, increasing recommended daily intake of fruit and vegetables to 600 g could lighten the world disease burden by 1.8%, and reduce ischemic heart disease and heart attacks by 31% and 19%, respectively, and stomach, throat, lung and colon cancer by 19%, 20%, 12% and 2%, respectively. The study demonstrates the potential long-term impact of increased fruit and vegetable consumption on reducing non-transmissible diseases (chronic and non-infectious diseases)[9].

Recent research has shown, what is more, that in a diet featuring sufficient calcium intake, fruit and vegetable consumption aids bone mass formation in children aged 8 to 20 years[9].

Research in children also shows that increased fruit and vegetable consumption may protect against cancer in adulthood[10]. In adults, a range of papers point to a link between increased fruit and vegetable consumption and lower risk of cancer and cardiovascular disease[11].

Fruit and vegetables support cardiovascular health through their diversity of bioactive substances, potassium and

fibre. Consumption of at least 400 g of fresh fruit and vegetables (including berries, green-leaf and cruciferous vegetables) a day is recommended to reduce coronary heart diseases, strokes and high blood pressure[4]. Although it was widely known that fruit and vegetables were healthy, the evidence of their protective effect against cardiovascular disease has only been fully identified in the past few years[12].

Increased fruit and vegetable consumption is especially important for preventing obesity. The factors encouraging or protecting against weight gain and obesity can be delineated as follows[4]:

1.- Proven links:

- Protective factors: regular exercise and high intake of NSPs (dietary fibre).
- Risk factors: sedentary lifestyle, high intake of calorie-rich foods with low micronutrient content.

2.- Probable links:

- Protective factors: school and family environment encouraging choice of healthy foods for children and breastfeeding mothers.
- Risk factors: mass advertising of calorie-rich foods, fast-food restaurants, high intake of soft drinks and sugared fruit juices. Adverse socio-economic conditions in developing countries, especially among women.

3.- Possible links:

- Protective factors: foods with a low glycemic index.
- Unrelated: protein content of the diet.
- Risk factors: large portions, high proportion of food prepared away from home (developed countries), alternating periods of strict dieting and inhibition.

4. Insufficient data:

- Protective factors: higher meal frequency.
- Risk factors: alcohol.

Two recent reviews of randomized tests have concluded that most studies show that NSP (dietary fibre) intake encourages weight loss [4].

Conclusions

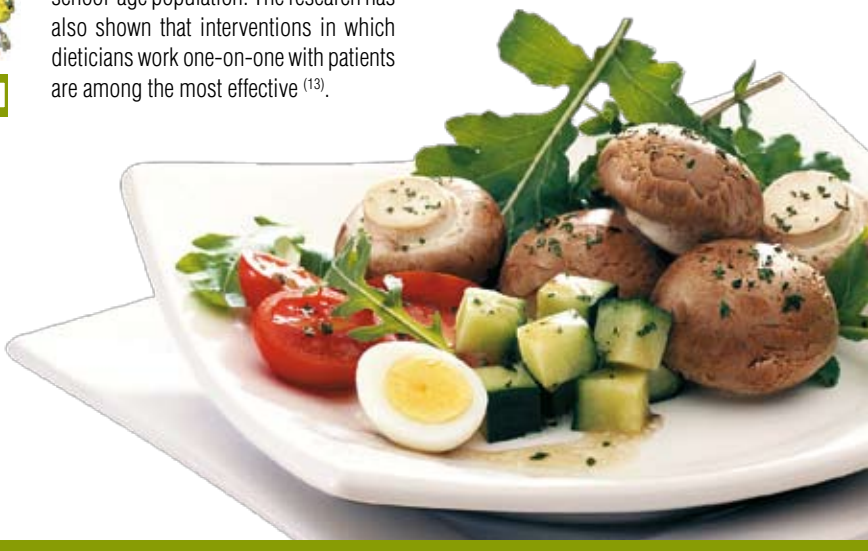
These interesting results highlight the need to pay closer attention to dietary risk factors and public health policy to face the world challenge of non-transmissible disease. But not all campaigns to raise fruit and vegetable consumption have met with success; many have been ineffectual or made only modest progress.

Consensus and cooperation among public and private bodies are essential to achieving the aims of any dietary education campaign aimed at the general public. A number of studies conducted by the FAO/WHO show that it is important to undertake integrated interventions that reach target groups from the various angles of modern society. Interventions providing fruit and vegetables and involving parents, teachers and peer groups achieve major successes in improving fruit and vegetable consumption in the school-age population. The research has also shown that interventions in which dieticians work one-on-one with patients are among the most effective [13].

Many countries have set in motion school-based education programmes to encourage higher consumption of fresh fruit and vegetables. Of these programmes, the most successful were those in which fresh fruit was provided for children to eat. Children receiving fresh fruit cut into slices increased their intake almost twice as much as children receiving the fruit whole. This shows that making fruit easy to eat may be an effective way of encouraging higher daily fruit and vegetable intake even in adults and the elderly.

The main barriers identified by consumers in achieving sufficient fruit and vegetable intake are lack of time and difficulty of preparation, and the fact that fruit and vegetables are not an attractive food for their daily diet. Many consumers acknowledge that they do not attain the fruit and vegetable consumption thresholds recommended by the FAO/WHO, and state that they are aware of the health benefits of fresh fruit and vegetables.

We need strategies to improve people's diet quality, raise fruit and vegetable consumption and encourage physical exercise to prevent diseases associated with low fruit and vegetable consumption.



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