

Special issue

A symposium to close the International Year of Fruit and Vegetables



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Jacques Brulhet is a Doctor of Veterinary Medicine, with a degree in biological oceanography and economics. He began his career in Asia (Cambodia) and Africa (Mauritania, Ivory Coast) between 1969 and 1986 as an advisor to various governments for the development of agriculture, fishing, and aquaculture. Between 1987 and 1998, he was responsible for the development of Pêche et Froid, a European leader in seafood products.

Returning to the French Ministry of Agriculture in 1998, he first contributed to the management of the main health crises (mad cow disease), to the implementation of new interprofessional tools and to the reform of the civil service.

Since his retirement from the administration, he remains a member of several boards of directors, in the agri-food industries and in the global development of sustainable fisheries. He remains President of the Union of Canned Fish Companies. Jacques Brulhet holds the Legion of Honour and the Agricultural Merit.

On December 14th, 2021, the French Academy of Agriculture had the pleasure of hosting the Symposium organised by Aprifel to close the International Year of Fruit and Vegetables.

The objectives set out for this International Year complement those of our Academy, since our watchword is to "live our passion and pass on our ambition".

The mission of the Academy of Agriculture is to study progress in the fields of agriculture, food and the environment, to explain the technical, economic, social and environmental issues, and to inform society and decision-makers.

This complementarity underlies the theme of the symposium: «*Review and perspectives concerning the health benefits of a diet high in fruit and vegetables*». The programme included a number of general presentations on the relationship between fruit and vegetables, health and sustainability. These were followed by a round table on possible approaches for increasing their consumption.

This special issue of the Global Fruit and Veg Newsletter is dedicated to the presentations made at the symposium. The following three articles describe the scientific approaches detailed during the symposium.

- Jean-Michel Lecerf has dual expertise as a doctor at the Institut Pasteur and a member of the Academy of Agriculture. His presentation focused on the health benefits of fruit and vegetables.
- Nathalie Delzenne, from the Catholic University of Louvain highlighted the healthy alliance of fruit and vegetables with our microbiota.
- Jean-Pierre Cravedi, toxicologist and President of the Scientific Board of Aprifel talked about changing knowledge and the health challenges raised by pesticide residues in our food.

Health benefits of fruit and vegetables

Jean-Michel Lecerf

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The public is familiar with the recommendation to eat “at least five portions of fruits and vegetables a day”, but few know the reasons behind it. Fruit and vegetables contribute to the recommended nutritional intake for a certain number of nutrients and micro-nutrients, but this is far from their only advantage.

Nutritional specificities and physiological effects

Fruit and vegetables have a number of shared characteristics: a high water content (between 85 and 95%), a low protein content and, more often than not, a low fat content, with a variable but modest carbohydrate content (between 2 and 20%). The main vitamins are beta-carotene, vitamin C, tocotrienols and tocopherols (vitamin E), and folic acid (vitamin B9). They also contain polyols and healthy micro-constituents such as phytosterols, polyphenols and carotenoids.

Owing to their low energy density, they have a favourable impact on our energy balance and therefore on weight control. Their volume and dietary fibre content contribute to a feeling of satiety. Fermentable fibres such as inulin and pectin, as well as polyphenols, have a significant impact on our microbiota and thus on intestinal health. Polyphenols and carotenoids have a strong antioxidant effect, while vitamins C and E have a preventive effect against carcinogenesis. At the same time, vitamin B9 plays a favourable role in the growth of maternal tissues during pregnancy and on the hematopoietic system (EFSA, 2012).

Some leafy vegetables contain omega-3 fatty acids in small but nevertheless appreciable quantities. They also contain minerals and trace elements such as potassium, which helps to regulate blood pressure by countering the effects of sodium, or magnesium and chromium, which are thought to have an impact on insulin sensitivity. Their alkalising effect is thought to account in part for their positive role in bone metabolism.

Health benefits of fruit and vegetables

Epidemiological studies have clearly shown the health benefits of regularly eating a variety of fruit and vegetables in preventing non-communicable diseases:

1) Cardiometabolic health: Type 2 diabetes and blood pressure

- The regular consumption of fruit and vegetables in significant quantities is associated with a lower risk of metabolic syndrome (Becerra-Tomás, 2021) and type 2 diabetes (Cooper, 2012). An interaction has been shown between diet and the genetic factors associated with diabetes. The benefits of eating fruit and vegetables increase with the level of genetic predisposition (Jia, 2021).
- All prospective epidemiological studies show that a high level of fruit and vegetable consumption decreases the risk of ischemic heart disease (Aune, 2017). This is due not only to the impact of fruit and vegetables on risk factors (weight, diabetes, high blood pressure) but also to the antioxidant properties of their constituents.

2) Cancer:

Many epidemiological case-control studies, particularly prospective studies, have shown an inverse relationship between fruit and vegetables consumption and the risk of certain cancers, owing to their antioxidant effect (Aune, 2017).

3) Neurodegenerative diseases:

Many studies point to the beneficial effects of polyphenol (flavonols, flavones, etc.) in preventing age-related cognitive decline and dementia, including Alzheimer's disease (Seners, 2021).

4) Ophthalmological diseases:

Some evidence has been found of the role of certain carotenoids (lutein and zeaxanthin) in preventing age-related macular degeneration (AMD), alongside other nutritional factors (long-chain omega-3 fatty acids, vitamin D) (Eisenhauer, 2017). Vitamin C appears to play a role, with lutein, in preventing cataracts.

5) Osteoporosis:

A significant body of evidence shows that fruit and vegetables consumption contributes to a lower risk of osteoporosis, owing to the alkalising «power» of organic salts and potassium (McTiernan, 2009). Naturally, this is in addition to other nutritional factors such as the consumption of dairy products.

KEY MESSAGES

- Fruit and vegetables contribute to a healthy balanced diet and adequate nutritional intake, as well as playing an important role in the prevention of most chronic diseases.
- Their consumption is associated with a broadly different lifestyle and diet, which is sometimes difficult to separate from the rest.
- To stay healthy, a daily consumption of at least five portions of a variety of fruit and vegetables is recommended.



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Pesticide residues: changing knowledge and health challenges

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Treating crops or harvests with phytopharmaceutical products can leave trace amounts on the foodstuffs consumed by humans.

Food contamination, consumer exposure and risk assessment

In its latest report on the measurement of pesticide residues in nearly 100,000 food samples taken in Europe in 2019 by the EU and its Member States, EFSA (2021) noted no quantifiable residues for 56.6% of the samples, with only 3.9% exceeding the maximum residue levels (MRLs). Taking account of the analytical uncertainties, only 2.3% of the samples exceeded the regulatory values, with most of the products concerned being from Asia or Africa. Based on these analytical results along with food consumption data for the European population, EFSA was able to estimate the exposure of the general population to pesticide residues in food. Following a comparison of these estimates with the acceptable daily intake (ADI) of each active substance, EFSA concluded that chronic dietary exposure to pesticide residues is unlikely to be a health concern for European consumers, based on current scientific knowledge (EFSA, 2021).

This conclusion is a reminder that the risk assessment of a substance, regardless of how rigorous or well regulated, can only be based on the scientific knowledge available at the time of the assessment. Nevertheless, science and knowledge are progressing rapidly, and may challenge the thresholds previously established or the methods used. This progress goes alongside with an increase in available data, often resulting in active substances being withdrawn from the market when they no longer meet the required safety criteria for the user, the consumer, or the environment. The non-renewal of marketing authorisations for active substances clearly shows that the limits of knowledge represent the main factor of uncertainty in hazard characterisation (Cravedi, 2019).

Scientific uncertainties

Examples of scientific and methodological developments

include the emergence of the concept of endocrine disruption, its inclusion in pesticide regulations, and the current hesitation around the criteria defining endocrine disruptors for plant protection products. These developments are likely to lead to the implementation of new toxicological tests previously unknown to applicants, and to have an impact on the health-based guidance values established.

Another regularly mentioned source of uncertainty is the lack of consideration given to interactions between active substances. Consumers face multiple sources of chemical stress that include not only exposure to several pesticides simultaneously, but also combined exposure to pesticide residues and hundreds of other food contaminants, for this route of exposure alone. It is difficult to fully understand the consequences of this multiple exposure, partly because its characterisation is imprecise, and also because data are lacking on the possible interactions between chemicals or even between contaminants and food constituents.

In 2021, Inserm published a collective expert report, reviewing the scientific literature concerning the health risks associated with occupational and environmental exposure to pesticides (Inserm, 2021). Based on the epidemiological studies listed, the report identified relationships between the exposure and the occurrence of certain diseases (neurodegenerative disorders, cancer, developmental disorders in the foetus and child). However, these increased risks are related to occupational exposure (more rarely domestic). None of the risks identified were associated with the presence of pesticide residues in food.

In order to support public policy-making on food, a risk/benefit approach should be preferred to a risk-only assessment. All studies taking this approach have concluded that the benefits of eating more fruit and vegetables far outweigh the risks associated with any pesticide residues that may be present (Reiss et al. 2012, Valcke et al. 2017).

KEY MESSAGES

- Although pesticides are hazardous substances, levels of consumer exposure to residues in food are low and do not pose a proven health risk, based on current knowledge.
- Nevertheless, a level of scientific uncertainty is still present in the risk assessment process, owing primarily to a lack of data on the possible interactions between substances. As a result, it is not possible to satisfactorily address the issue of multiple exposure.



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Fruit, vegetables, and microbiota: an alliance promoting health?

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The study of microbiota is a complex field of research. Since 2008, the number of studies in this area has increased exponentially thanks to new advances in analytical methods. Disruption of the microbiota, particularly the gut microbiota, can be observed in many chronic diseases. Understanding the links between microbiota and diseases is therefore essential and is seen as a potential avenue for new therapies.

Microbiota, an 'organ' specific to each individual

The microbiota represents all the micro-organisms (bacteria, viruses, fungi, yeasts, etc.) living in a specific host environment. There are five types of microbiota (gut, vaginal, skin, respiratory, and oral) associated with the human body. Gut microbiota – the type most frequently studied – represents 100,000 billion micro-organisms alone. The density of these micro-organisms increases from the stomach to the colon. In a healthy adult, the bacteria composing the gut microbiota belong to two major phyla – Bacteroidetes and Firmicutes – which constitute around 85% of gut flora.

Each individual has their own specific microbiota, evolving throughout their lifetime

Two criteria have been identified for the quality of the microbiota: composition and diversity. Both of these depend on several characteristics specific to each individual (age, sex, genetic heritage), childbirth method, whether or not they were breastfed, and the way they live (diet, stress, medication, infectious and toxic agents).

Disruption of the microbiota observed in many diseases

Diet is one of the key factors governing not only the composition but also the activity of gut microbiota. The micro-organisms in the microbiota feed on the substances present in food (particularly fibre), contributing to the digestion and metabolism of all sorts of nutrients.

In many of the chronic diseases generally associated with an unbalanced diet (cardiovascular diseases, cancer, diabetes, obesity), a disruption to the microbiota (dysbiosis) can be observed. This dysbiosis in turn modifies intestinal permeability. This favours the passage of molecules such as bacterial metabolites, xenobiotics, bacterial lipopolysaccharides and branched and aromatic amino acids, responsible for low-grade systemic inflammation (Lecerf JM, 2021).

Fibre at the heart of microbiota modulation

Diet is one of the key factors modulating the microbiota. Plant-based foods are particularly rich in nutrients considered as prebiotics. These are the real 'fuel' for the bacteria in gut microbiota. They have wide-ranging protective effects on the intestine, both directly (mucus, etc.) and indirectly by releasing into the intestine active substances able to promote good health. More specifically, fruit and vegetables are rich in dietary fibre, which can influence the composition and diversity of gut microbiota and thus contribute to preventing certain diseases. In fact, dietary fibres produce short-chain fatty acids able to act on the receptors specific to each disease (obesity, diabetes, cancer, inflammation, immunodeficiency) (Cui, 2019).

Some dietary fibres may contribute to reducing obesity and associated diseases. This is the case of inulin-type fructans, found in vegetables such as leeks, Jerusalem artichokes, globe artichokes, salsify and onions. A study of 26 healthy individuals showed that a high consumption of inulin-rich vegetables is well tolerated and leads to significant reversible changes in gut microbiota, including an increase in Bifidobacterium. The authors also noted an increase in Prevotella along with a decrease in Oscillibacter sp., Lachnospiraceae, and Alistipes. These findings are interesting for the monitoring of metabolic alterations. Participants noted a reduction in intestinal discomfort, associated with the frequency of Clostridium cluster IV and Ruminococcus callidus (Bindel, 2013; Hiel, 2019).

Polyphenol nutrients of interest in microbiota modulation

Dietary fibres in fruit and vegetables are not the only nutrients of interest in this context. Fruit and vegetables also contain other nutrients such as polyphenols, flavonoids and other phenolic derivatives that are also potential prebiotics. Their interaction with microbiota could partly explain their protective effect against cardiovascular disease (Cui, 2019).

KEY MESSAGES

- Diet influences the composition and activity of gut microbiota.
- In most diseases associated with a dietary imbalance, disruptions can be observed in gut microbiota.
- Fruits and vegetables are rich in both dietary fibre and nutrients. These are considered as prebiotics (polyphenols), able to modulate the microbiota.



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Nutritional risk factors for SARS-CoV-2 infection: a prospective study within the NutriNet-Santé cohort

In order to assess the potential effect of diet and the risk of SARS-CoV-2 infection, analyses were performed in the French NutriNet-Santé cohort. 7,766 adults (70.3% women, mean age 60.3 years) were included, 311 of whom had anti-SARS-CoV-2 antibodies, showing that they had been infected by the virus. According to this work, high dietary intakes of fruit and vegetables and, consequently, of vitamin C, folate, vitamin K and fibre are associated with a decreased probability of SARS-CoV-2 infection. In contrast, dietary intakes of calcium and dairy products are associated with an increased probability.

Deschasaux-Tanguy M, et al. BMC Med. 2021;19(1):290.



Fruit consumption and multiple health outcomes: An umbrella review

A review of 59 studies showed that increasing fruit consumption by 200 g per day reduces the risk of breast cancer. The risk of diabetes could be reduced by 8-12% with an increased fruit intake of 100-500g per day. "Moderate" evidence also suggests that an extra portion of fruit per day (80-100g) could reduce the risk of coronary heart disease and oral cancer. Finally, this work shows no adverse effects associated with fruit consumption. The authors highlight the need for randomized controlled trials or prospective studies on large, multicenter, and multinational samples to confirm these results.

Liuqiao Sun, et al. Trends in Food Science & Technology, 2021; 118 : 505-518.



Nutrition education strategies to promote vegetable consumption in preschool children: the Veggies4myHeart project

A team of researchers tested the effectiveness of three nutrition education strategies - a digital game, a storybook, and the use of stickers - on vegetable consumption in preschool children (3-6 years). In 4 preschools in Portugal (162 children included), 20-minute educational sessions took place once a week for 5 weeks. In parallel, children were repeatedly exposed to vegetables. All three strategies tested were effective in increasing vegetable consumption in these children, including the use of stickers (as a reward).

Braga-Pontes C, et al. Public Health Nutr. 2021 Oct 27:1-10.



Fresh Fruit Consumption, Physical Activity and Five-year Risk of Mortality among Patients with Type 2 Diabetes: A Prospective Follow-up Study

A prospective study evaluated the associations between fruit consumption, physical activity level and mortality risk in patients with type 2 diabetes (20,340 patients aged 21 to 94 years). According to this study, daily fruit consumption reduces the risk of mortality from cardiovascular disease and stroke, as well as all-cause mortality (24% reduction with a daily consumption of one portion (80 g) of fruit). These benefits are observed at low levels of consumption - from half a portion of fruit per day (43 g or more). On the contrary, when low fruit consumption and low level of physical activity are associated, a higher risk of mortality is observed.

Yijia Chen, et al. Nutrition, Metabolism and Cardiovascular Diseases, 2021.



VeggieSense: A non-taste multisensory exposure technique for increasing vegetable acceptance in young children

According to the literature, allowing children to discover vegetables using senses other than taste is a lever for acceptance of these foods. In order to examine this impact, an intervention study was carried out in a nursery in the UK. 110 children aged 3 to 4 years were divided into 4 groups. Three intervention groups were exposed to six vegetables (raw and cooked) using one or more senses: (a) sight, (b) smell and sight, or (c) smell, touch, and sight. The control group participated to an activity involving visual exposure to non-food products. The children's willingness to taste and eat vegetables was then assessed. Children in group (c) who were exposed to vegetables via three senses showed the highest level of acceptance.

Roberts AP, et al. Appetite. 2022;168:105784.