THE CHALLENGES OF SOME HORTICULTURAL CROPS IN THE INTERNATIONAL YEAR OF FRUITS AND VEGETABLES

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Abstract

In the International Year of Fruits and Vegetables, the role of some horticultural crops in the human diet and health has special relevance. For this reason, the importance in agricultural production of some vegetables belonging to the Fabaceae and Brassicaceae families are briefly reviewed.

Resumen

En el Año Internacional de las Frutas y Hortalizas, el papel de algunos cultivos hortícolas en la dieta y la salud humana tiene especial relevancia. Por ello, se revisa brevemente la importancia en la producción agrícola de algunas hortalizas pertenecientes a las familias Fabaceae y Brassicaceae.

The International Year of Fruits and Vegetables

The year 2021 has been designated by the United Nations (UN) General Assembly as the International Year of Fruits and Vegetables (IYFV). The IYFV is a unique opportunity to raise awareness of the important role of fruits and vegetables in human nutrition, food security and health as well as in achieving the UN Sustainable Development Goals (International Year of Fruits & Vegetables 2021).

The four objectives of the 2021 IYFV are:

- Raising awareness of and directing policy attention to the nutrition and health benefits of fruits and vegetables consumption.
- Promoting diversified, balanced, and healthy diets and lifestyles through fruit and vegetable consumption.
- Reducing losses and waste in fruits and vegetables food systems.
- Sharing best practices on promotion and consumption, improved sustainability, supply chains and capacity strengthening.

The 2021 IYFV falls within the UN Decade of Action on Nutrition (2016-2025) and the UN Decade of Family Farming (2019-2028). FAO is the lead agency for celebrating the year in collaboration with other relevant organizations and bodies of the United Nations systems.

The horticultural crops and products

It is generally accepted by researchers in horticultural science that horticultural crops include mainly herbaceous annual plants and also perennial trees and shrubs:

- Vegetables (roots, tubers, shoots, stems, leaves, fruits and flowers of edible plants)
- Aromatic and medicinal foliage, seeds and roots (from annual or perennial plants)
- Trees and shrubs for use in landscaping or for fruit production

Horticultural products include all materials, raw or processed, that arise from the horticultural production and industry. The products of the horticultural production that are still fresh on the market are the products most properly considered as horticultural ones. When transformed into juice, fermented, frozen, preserved, canned, dried, irradiated or used in an ornamental construction (such as a floral arrangement), they remain, from a broad point of view, as horticultural products (https://www.ishs.org/defining-horticulture).

Fabaceae

Legume species belong to the Fabaceae or Leguminosae family and are characterized by their fruit, usually called pods. Several species of this family were domesticated by humans, such as soybean, beans, faba bean, pea, chickpea, lentil, peanut, lupine, pigeon pea, mung bean, peanut, or cowpea. Food legumes are typically consumed as human food and animal feed as dry seeds, due to their high protein content. In many cases legumes has a relevant role in the human diet as vegetables for their immature seeds or pods (Blair et al. 2016). Members of the legume family fill critical niches in most terrestrial biomes. This is one of the few plant families whose species are capable of "fixing" nitrogen from the air, through association with specialized soil bacteria (rhizobia), for use as a natural fertilizer, thus reducing chemical fertilizer requirements and reducing the emission of greenhouse gases (mainly NO_x oxides), which contribute to the climate change. The overall goal of legume production is to increase the sustainability of the food and feed chain at all its steps, meet the requirements of citizens for safe, healthy and affordable food and assure food quality and authenticity. Reducing energy and water consumption and optimizing process control contribute to making food processing and distribution more sustainable and the food sector more competitive (De Ron 2015).

Main horticultural crops

1. Common bean (*Phaseolus vulgaris* L.).

The common bean is an annual species predominantly self-pollinating. Common bean consists of two major gene pools, Mesoamerican and Andean, characterized by partial reproductive isolation, which include wild populations and cultivated varieties. The common bean is the third most important food legume crop worldwide, surpassed only by soybean (*Glycine max* L.) and peanut (*Arachis hypogea* L.). Among the main food crops, the common bean shows the greatest variation in growth habit, seed characteristics (size, shape, and colour) and maturation time.

This variability enables its production in a wide range of cropping systems and environments as diverse as the Americas, Africa, the Middle East, China, and Europe. Despite being cultivated for its fresh pods (Pérez-Barbeito et al. 2008) and grains, beans are produced and consumed as dry legumes.

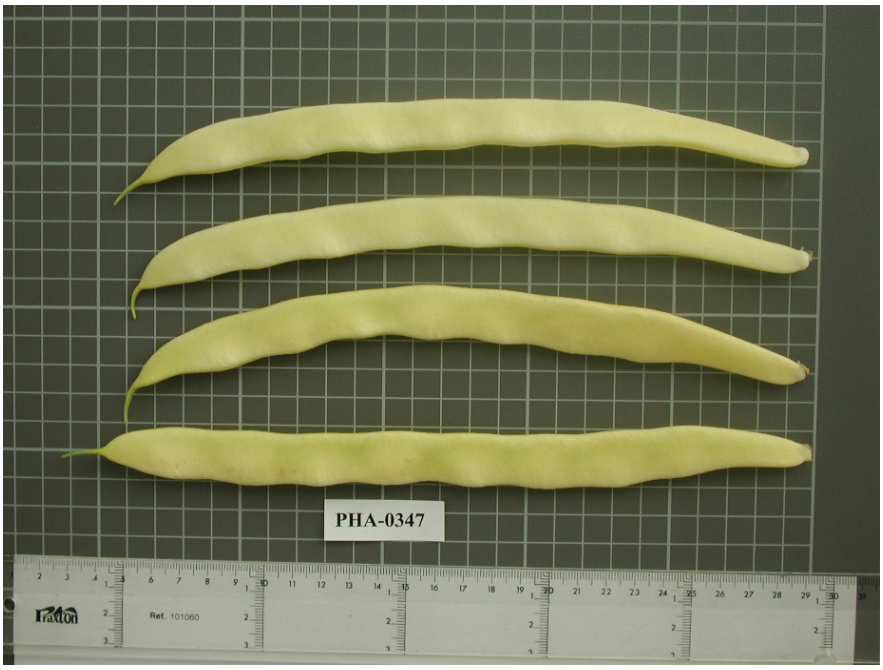

Figure 1. Yellow-podded snap bean.

Figure 2. Flageolet bean seeds.

2. Pea (*Pisum sativum* L.).

It is one of the first domesticated crops and is currently grown in most temperate regions of the world. Vegetable pea production has been rising steadily over the past 50 years with China and India being the major producers. The centre of pea genetic diversity is the broad area of the Fertile Crescent through Turkey, Syria, Iraq, Israel and Lebanon. It extends further east to Central Asia (Iran, Afghanistan, Pakistan and Turkmenistan). Vavilov (1950) considered Ethiopia together with the Mediterranean and Central Asia as primary centres, and Near East as secondary. Vegetable pea varieties are cultivated for their fresh pods and grains (Amurrio et al. 1996, Santalla et al. 2001, De Ron et al. 2005, Blair et al. 2016).

Vegetable peas include:
Snow pea varieties, edible-pod peas with flat pods and thin pod walls that are eaten whole, both the seeds and the pod, while still unripe.
Garden pea varieties, with edible green coloured immature grains.
Sugar pea, varieties of garden pea with flat edible pods without fibre when immature.
Tear pea varieties, mini-vegetables with very small edible immature grains in an embryonic stage (De Ron 2018) (Figure 3).

Figure 3. Tear pea.

3. Soybean (*Glycine max* L.).

Soybean is an annual legume crop of eastern Asian origin and is grown predominantly for its grains. World-wide it is an important source of high-quality protein and vegetable oil (Maestri et al. 1998). The grains contain approximately 38% to 42% protein and 18% to 23% oil at maturity (Dornbos and Mullen 1992, Clemente and Cahoon 2009). Apart from the commodity (grain-type) soybeans, which are mainly used for livestock feed, a second type known as vegetable-type soybean is specifically grown for human consumption.

Vegetable-type soybean is a large-seeded (Figure 4) speciality type that is harvested immature at the R6 growth stage. It is known as ‘edamame’ in Japan, ‘mao dou’ in China and ‘poot kong’ in Korea (Lumpkin et al. 1993) and is much more common across East Asia and Japan than in the rest of the world (Mebrahtu and Devine 2008). Vegetable-type soybean is produced and sold as pods-on-stems, loose pods or shelled beans and the beans can be consumed as a snack or vegetable depending on the dish being prepared. The shelled beans can be prepared in various ways such as being steamed, boiled, stir fried or used in soups. The mature grain can be roasted, flavoured (sweet or savoury) and consumed as a healthy snack. Soybean is valued because of its high and complete protein content, high essential fatty acid content and micronutrient (vitamins and minerals) content (Zeipinia et al. 2017). Similarly, mature vegetable-type soybean also contains these nutritional quality components, although studies showed that some cultivars might have higher levels of especially vitamin K, folate and other micronutrients (Guo et al. 2019). Since the fresh beans contain a higher mineral and vitamin content, they are preferred above the mature grains for consumption. Compared to commodity soybean, vegetable-type soybean has a nutty, mild flavour and sweet taste that are more popular for fresh consumption.

Figure 4. Large-seeded vegetable-type soybeans at mature stage.

Thus, vegetable-type soybean is one of only a handful of plant-based foods that contains lysine and tryptophan, which is lacking in other grain crops such as wheat and rice, with a high content of sucrose and is a rich source of secondary metabolites (Zhang et al. 2017).

4. Faba bean (*Vicia faba* L.)

It is a rich protein grain legume with a long tradition of cultivation in the temperate zone of the northern hemisphere. Sometimes also referred to as horse bean or broad bean, it is mostly harvested as dry seeds for food or feeds, but its fresh seeds or pods can also be used as vegetables. Faba bean provides valuable ecological and environmental services in sustainable agriculture, diversity in cropping systems and host numerous associated organisms including pollinating insects. Seed size is important for meeting market and farmer needs, although it is a continuously variable property. Large-seeded cultivars are widely favoured for food use, whether as a fresh green vegetable or, in many cultures, dry. The genetic variability of the species is quite large and often described based on differences in seed weight, shape and size. Muratova (1931) cited four botanical varieties: the large-seeded faba bean (*V. faba* sp. *faba* var. *major*), with a seed weight of more than 1g and developed in the South Mediterranean regions and China; *V. faba* sp. *faba* var. *equina*, with an intermediate seed size (0.45–1.1 g per seed), developed in the Middle East and North Africa; *V. faba* sp. *faba* var. *minor* (0.2–0.5 g per seed) found in the Ethiopian highlands, Sudan and in Northern Europe; and *V. faba* sp. *paucijuga* grown in Central Asia.

5. Yard-long bean (*Vigna unguiculata* subsp. *sesquipedalis*) (Figure 5).

It is a vigorous climbing annual legume cultivated for its very long edible green pods containing immature seeds. Despite its name ("yard-long") the pod length is usually about 0.5 yd long. The different varieties are usually distinguished by the different colours of the mature seeds. This crop is subtropical/tropical and most widely grown in the warmer parts of South Asia, Southeast Asia, and southern China.

Figure 5. Pods of yard-long bean.

Brassicaceae

The Brassicaceae family, commonly termed the mustard family or Cruciferae, includes a wide range of horticultural crops, many of them with economic significance and extensively consumed as commodities and used in the industry worldwide. The principal vegetable species are *Brassica oleracea* (i.e., cabbage, kale, broccoli, cauliflower, or Brussels sprouts), *Brassica rapa* (i.e., turnip, turnip greens, turnip tops, Chinese cabbage, pak choi), *Brassica napus* (i.e., rapeseed, leaf rape and rutabaga), *Raphanus sativus* (radish), and *Sinapis alba* (mustard).

Brassica oleracea and *B. rapa* are the most important vegetables species within this family. They have much more phenotypic and genetic diversity than *B. napus*. The main reason for such diversity is that all these crops have been selected over many centuries by producing divergent plant forms that are markedly different in their use and morphological, agronomical and nutritional traits (Branca and Cartea 2011). The greatest genetic and phenotypic variability of *B. oleracea* is found in Europe, while Asia represents the main area of diversification of vegetable *B. rapa* crops.

1. Cole crops (*Brassica oleracea* L.)

Brassica oleracea is a versatile species that under human selection has generated several crops (Table 1), each targeting to a different organ of the plant (leaves along the stem: kales; leaves surrounding the terminal bud: cabbage; enlarged axillary buds: Brussels sprouts; inflorescences: cauliflower and broccoli; swollen stem: kohlrabi and marrow stem kale) (Figure 6). There are several types of cabbages: white cabbage, red cabbage, and savoy. Portuguese cabbage forms a loose head and can be considered an intermediate form between typical white cabbages and kale. These different crops have been classified as varieties or convarieties, although under modern terms they would be cultivar-groups (Ordás and Cartea 2006).

2. Turnip and leaf type crops (*Brassica rapa* L.)

Brassica rapa is an important oil and vegetable crop in many parts of the world, whose seeds are used for oil, and leaves, flowers, stems and roots are used as vegetables. *B. rapa* vegetables are consumed worldwide and provide a considerable proportion of the daily food intake in many regions of the world.

Cultivation of this species for many centuries in different parts of the world has caused a large variation in the plant organs that are consumed (roots, leaves, and flower buds), which has resulted in the human selection of different morphotypes, depending on local preferences (Padilla et al. 2007, Cartea et al. 2021). Based on their morphological appearance and on the organs used, *B. rapa* crops can be classified into two groups:

a) Vegetable types used for their tubers (=hypocotyl), leaves and flower buds, which include the *rapa* group and the leafy vegetable forms (Figure 7).
b) Oleiferous types, of which canola is a specific form, having low erucic acid levels in its oil and low glucosinolate content in its meal protein.

Table 1. Crops from the species *Brassica oleracea.*

Cultivar group	**Common name**
Acephala	Kale and collards
Alboglabra	Chinese kale
Botrytis	Cauliflower
Capitata	Cabbage
Sabauda	Savoy
Costata	Portuguese cabbage (tronchuda)
Gemmifera	Brussels sprouts
Gongylodes	Kohlrabi
Italica	Broccoli
Medullosa	Marrow stem kale
Ramosa	Thousand head kale

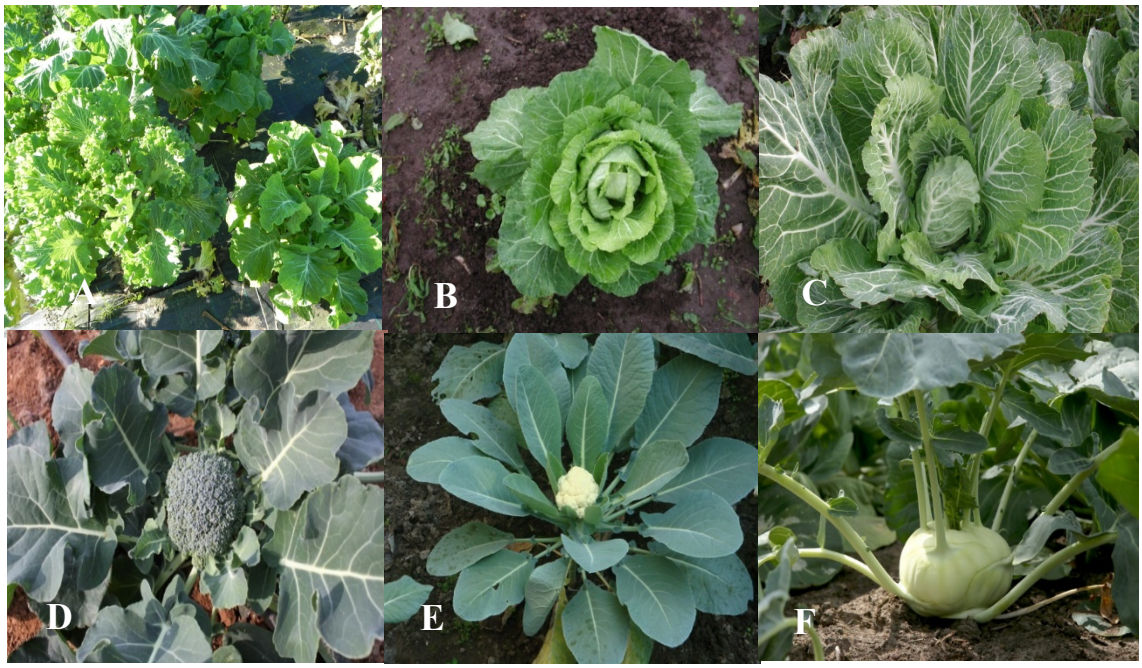

Figure 6. Vegetable crops from the *Brassica oleracea* species: kales (A), cabbages (B), Portuguese cabbage (C), broccoli (D), cauliflower (E), and kohlrabi (F).

A B C

Figure 7. Leafy vegetable crops from the *Brassica rapa* group: Turnip (A), turnip greens (B) and turnip tops (C).

Bioactive compounds and diet

Although vegetable cruciferous plants are sources of fibre, folate, vitamins (A, E, C, and K) and minerals (Ca, Fe, K, Cu, Zn, P, Mn, and Mg, among others), the major body of evidence in the scientific literature is concentrated in the contents of secondary metabolites, especially glucosinolates. In recent decades, these compounds and their derived forms, isothiocyanates (ITC), have attracted the interest of scientific community because these bioactive compounds have been associated with some important human health benefits including the reduction of the risk of certain cancers and cardiovascular diseases (Traka 2016). Other crucial metabolites in Brassica crops because of their therapeutic value are phenolic compounds, especially flavonoids (Francisco et al. 2011, Cartea et al. 2011). The main important biological effects derived from these compounds are the antioxidant activity, the capillary protective effect, and the inhibitory effects elicited in the various stages of a tumor. All of these phytochemicals contribute to the antioxidant, anticarcinogenic, and cardiovascular protective activities of Brassica vegetables (Podsedek 2007, Jahangir et al. 2009), which increase their value as therapeutic compounds to be used in medicine and as food supplements in the human diet.

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