VEGETABLES II (OTHERS)

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Contents

Summary

In this chapter, vegetables grown for their fruits, seeds and edible pods are focussed on. They are produced for their high nutrition value, since they contain high amount of water, sugar, vitamins, essential minerals, specific phytochemicals and flavour and aromatic substances. Fruit vegetables are preferred for their clean water, sugar, acid, vitamin and fibre content and taste, while green legumes are consumed also for their proteins.

Since fruit vegetables are mainly hot season crops, they are sensitive to cool temperature and low light conditions. In some developed countries in the Northern Hemisphere very high and profitable hothouse production can be reached, though expenses of labour and energy are high. Profitability is a consequence of the high demand of the food industry for tomato, bell pepper and cucumber in the market.

Green peas and snap beans are cool season crops and intensively grown in developed countries. Their cultivation is one of the most mechanised, strictly regulated high technological practices of arable crop production, which satisfies the industrial requirements for frozen and canned products. Developed cultivation technologies and new genotypes with improved yield potential and stability contribute the increased gross yields.

Vegetable quality depends not only on cultivation but also on post-harvest treatments. It is true for the industrial processing as well, which may reduce significantly the valuable vitamin content of the product, as it is shown for green peas and beans.

There are many fruit crops and vegetable legumes, which are grown in tropical countries, in arable fields, in periurban areas and home gardens. Cultivation practices, yields, use and profits are quite different from those of in developed countries.

1. Introduction

An adequate and balanced diet always contains sufficient amount of essential micronutrients. The best solution is the consumption of vegetables and fruits, which are good sources of vitamins and minerals as well as dietary fibres. People diversify their diets and raise the consumption of vegetables not only reduce the risk of vitamin and mineral deficiencies, but intake these micronutrients together with that particular chemical environment contained by the plant tissues, clean water, sugars, dietary fibres and specific phytochemicals. Additionally, the appetizing flavour and aroma substances of vegetables make the meal more delightful and promote digestion.

In a practical point of view vegetables are grouped according to the plant part, which is consumed. Some properties, role in nutrition, production and processing of vegetables produced for roots, tubers, leaves, stems or metamorphosed stems are the subject of the Article 5.5.2.3.1. in this volume entitled “Vegetables: Rootcrops”.

Figure 1: Vegetables marketed in Katmandu, Nepal. (Photo: Erzsi Voith)

In this article the vegetables grown for fruits, edible pods and seeds are focussed on. They are classified in the following botanical classes and families: Fabaceae (beans, peas, soybean), Solanaceae (tomato, green pepper, eggplant), Cucurbitaceae (melon, pumpkin, squash). Regarding the taxonomic list, it is clear, that many species, which are taxonomically close to each other, were involved in the domestication procedure for similar edible part of the plant in neighboured as well as in far-off regions. Those are mainly fruits for Cucurbitaceae and Solanaceae, and seeds and pods for Fabaceae.

2. Tomato

Tomato is one of the world’s most important vegetables. Consumption is high both for fresh fruits and for industrial processing of tomato puree or concentrates. Oriental and

Italian cuisine are very popular all over the world, and tomato is a basic material of both. Additionally, tomato widely can be applied in a healthy diet.

The largest producer countries considering cultivation areas are China, the USA, Italy, Turkey, Greece and Spain (Fig.2.). In developing countries India had a large production, which was 6,218,470 metric tons of tomato per year in average in the end of the last century (source: Indian National Horticultural Board 1998/99). In Europe glasshouse production has a high contribution to yield.

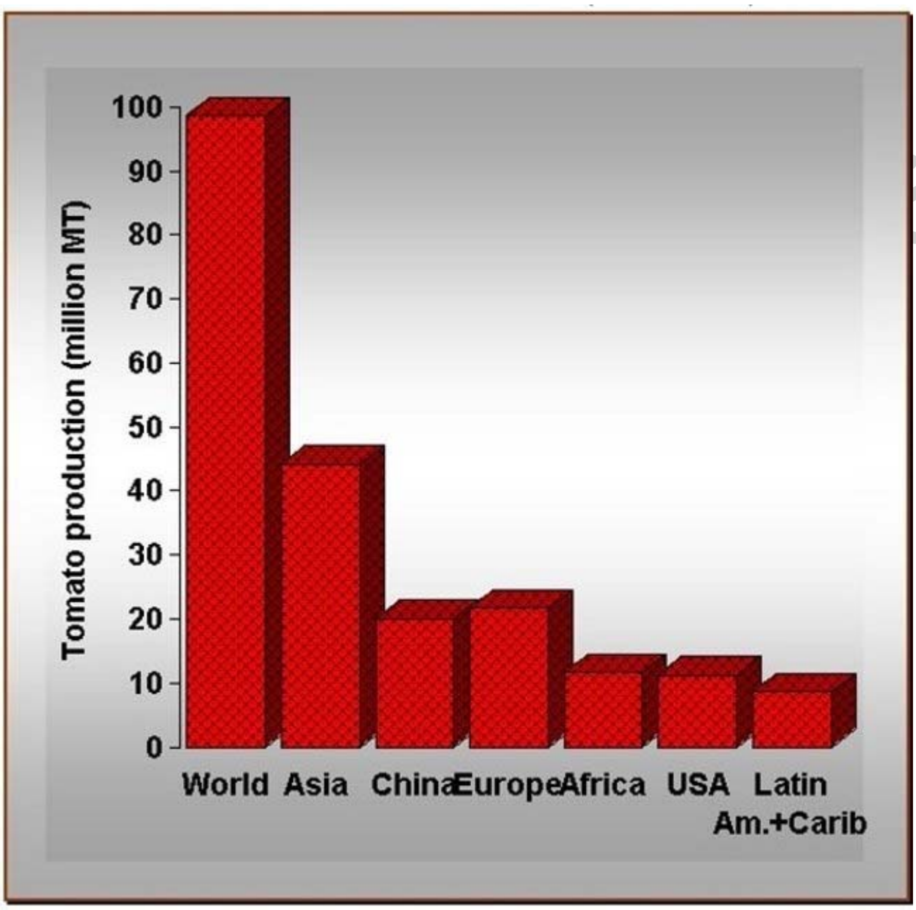

Figure 2: Tomato production in the world in 2001 (source: FAOSTAT)

2.1 Description of tomato

Tomato (Lycopersicum esculentum Mill.) botanically is a member of the Solanaceae plant family and its fruits are consumed (leaves and stems contain various poisoning glyco-alkaloids like solanine, which disappear from the fruits while ripening). It had been cultivated in South- and Central America before Columbian time. The six wild species of the subgenus Eulycopersicon and Eriopersicon are valuable sources of genes used in breeding for the resistance against pests and diseases and for improved properties. First the yellow variety of tomato has been brought into Europe and got the name: pomo d'oro (golden apple).

Tomato fruits are more or less spherical, red or yellowish berries (Fig. 3.) with various sizes, from the smallest "cocktail" varieties to the biggest ones produced for food industry.

Figure 3: Tomato for salad (Photo: Martin Rajkai)

The fruits contain the juice, not-soluble pigments (lycopene, carotene, xanthophylls, chlorophyll), pectin and pectin solubilizing enzymes, and in the middle the small, oval seeds on the placenta. During ripening fruit colour turns from green to red while chlorophyll is breaking down and lycopene is being synthesised, and the production of volatile components increases resulted in the specific aroma of the tomato.

The characteristics of the good quality of the marketable fruits are mainly external characters such as brilliant red colour, uniform size and shape, degree of ripeness, firm under the knife, skin without cracks. For industrial tomatoes quality components are high contents of dry matter, acids and lycopene. Tomatoes of high biological value have high carotene content, high vitamin C and lycopene contents and balanced mineral content.

Tomato yields and composition depend on the genotype, conditions of cultivation and climate, or forcing, soil properties and water supply. The main nutrient constitution of tomato is shown in Table1.

Dry matter	3300-9400	Potassium	244-576	Vitamin C	6.0-30.0
Carbohydrate	1400-4000	Calcium	10-14	Thiamine (B1)	0.02-0.10
Proteins	200-1100	Magnesium	2-30	Riboflavin (B2)	0.04-0.16
Fat	200-300	Phosphorus	15-31	Niacin	0.17-0.40
Pectin	200-500	Iron	0.3-0.9	Pantothenic	0.17-0.40
Cellulose	250-1100	B-carotene	0.10-0.30	Vitamin B6	0.15-0.25

Table 1: Nutrient contents in tomato (mg nutrient per 100 g fresh mass)

Carotenoid formation is influenced by light and temperature. The optimum temperature range is between 25 and 30°C for the formation of tomato colouring carotenoid lycopene but carotenes are developing above 30°C too, influenced by light. That means, that storage of nearly ripe tomatoes at optimum temperature (for example during transportation) can improve colour, but not carotene content. Comparison of those harvested unripe and subsequently ripe with those harvested when fully ripe showed that after-ripened fruits have lower contents of dry matter, total sugar, ascorbic acid, and sometimes carotene, but higher lycopene content.

2.2 Cultivation and constraints

According to their tropical origin tomatoes are sensitive to cool temperature and low light conditions. In Europe with hothouse/planthouse tomatoes it was established, that by the reduction of sunlight in the winter months from November till January the sugar content and the total acid content continuously diminished, which markedly altered the taste.

Also their growth and yield are definitely sensitive to light. Biomass accumulation and development are influenced by the intensity, duration and quality of light. The duration of light determines the photoperiodic reaction of flowering, while light composition affects growth. Temperature is an important controlling factor of growth and yield, and the harmonization of the soil and canopy temperature with light, water, and nutrient supply is essential particularly in glasshouse conditions. When cloudy, it is better to maintain lower temperature than in sunny days in the glasshouses. Just before flowerage low night temperatures unfavourably affect carbohydrate partition in the plant and, this way, flowering. In the initial phase of fruiting both too low and too high temperatures reduce yield. During ripening lycopene synthesis is hindered by high temperature (above 32°C). Generally, higher temperatures increase early yield, but reduce gross field yield.

Tomato can exploit water from the deeper soil layers by its deep root system. Its water demand is high due to the long growth cycle and the large transpiring leaf area. The rate of its water use is affected by the genotype, site, agro-technical and climatic conditions. Water supply is critical in the initial phase of fruiting and during ripening. Nutrient requirement is high, both organic manure and mineral fertilizer application is recommended. Starter phosphate fertilization, nitrogenous top-dressing during fruit initiation and foliar application of micro- or/and macronutrients when needed, affect beneficially on yield. However, over-fertilization by nitrogen often leads to loss of taste and aroma.

Tomato production involves many activities such as soil tilling (deep loosening, top cultivation, hoeing), planting, cutting the tendrils off, removing leaves, vibrating for the promotion of pollenisation, mulching, supplying sufficient light, temperature, water and nutrients, chemical and mechanical plant protection, careful picking, sorting, packing and transportation of the fruits. In a case of acceptable knowledge and farming experience the profitability is a result of the interactions among production, marketing and economic factors. The relation of the production expenses to the earnings shows the profitability, which is highly affected by the yield. Production expenses are the highest, thus determinant for planthouse cultivation.

3. Green pepper: Capsicum annuum

Since its domestication green pepper has been used as food and also as spice. As food its vegetable varieties are consumed in several dishes: in hot meals stuffed, or mixed with meat and cooked, fried, steamed; when fresh as constituents of various salads, or pickles. Vegetable pepper is a basic substance of the oriental cuisine and widely popular in the world for its good taste and high vitamin C content.

In the 1990s world production was more, than nine thousand metric tons of green peppers and chillies, with six and half thousand metric tons for developing countries. China and Nigeria are the leader producers of vegetable pepper, while Italy, Holland and Hungary are among the top ten from Europe, and Mexico and US in the Americas.

3.1 Description of green pepper

Cultivated vegetable pepper namely: paprika, sweet pepper, bell pepper varieties belong to the genus Capsicum, which is associated with other genera (Solanum, Lycopersicum) of the Solanaceae tribe. By the Tehuacán Valley excavations southeast of Mexico City supplied the evidence, that American Indians were manipulating and domesticating Capsicum plants as early as 7000 and 6000 BC. Capsicum was also found in Peru sites from 3000 and 2000 BC origin. American Indians bred different Capsicum stocks for vegetable and for spice.

The fruits of the wild species are small, only some centimetres long with high capsaicin content. Capsaicin is an alkaloid, which provides the pungent taste to the hot varieties of green peppers known as chillies. This biogene amine alkaloid is a vasodilator and widely used in plasters for the mitigation of rheumatic pains. Those suffering from kidney diseases should avoid this irritating substance. The vegetable (sweet) pepper varieties have big fruits with very low, some 250-500 μg capsaicin per fruit. The fruits are green, yellow or red. Colour, shape and size are characteristic to the variety. Size, weight, the appearance and taste of the fruits are decisive in the first place for allocation in the trade classes. However, in many cases morphological characteristics cannot be found as directly interacting with the proportion of the valuable constituents or nutritive value. No connection has been found between the form or colour of the green pepper and the sharpness caused by capsaicin, but it is known that the different shaped cultivars, “grossum” and “longum” - the sack shaped fruits with thick wall, and the elongated ones with thinner wall - differ in vitamin C content. Generally, changes in thickness of fruit wall seem to affect the vitamin C content of the green pepper.

3.2 Nutrients in green pepper

Vegetable green pepper is in the top three among vegetables regarding its average nutritive value (Fig.4.).

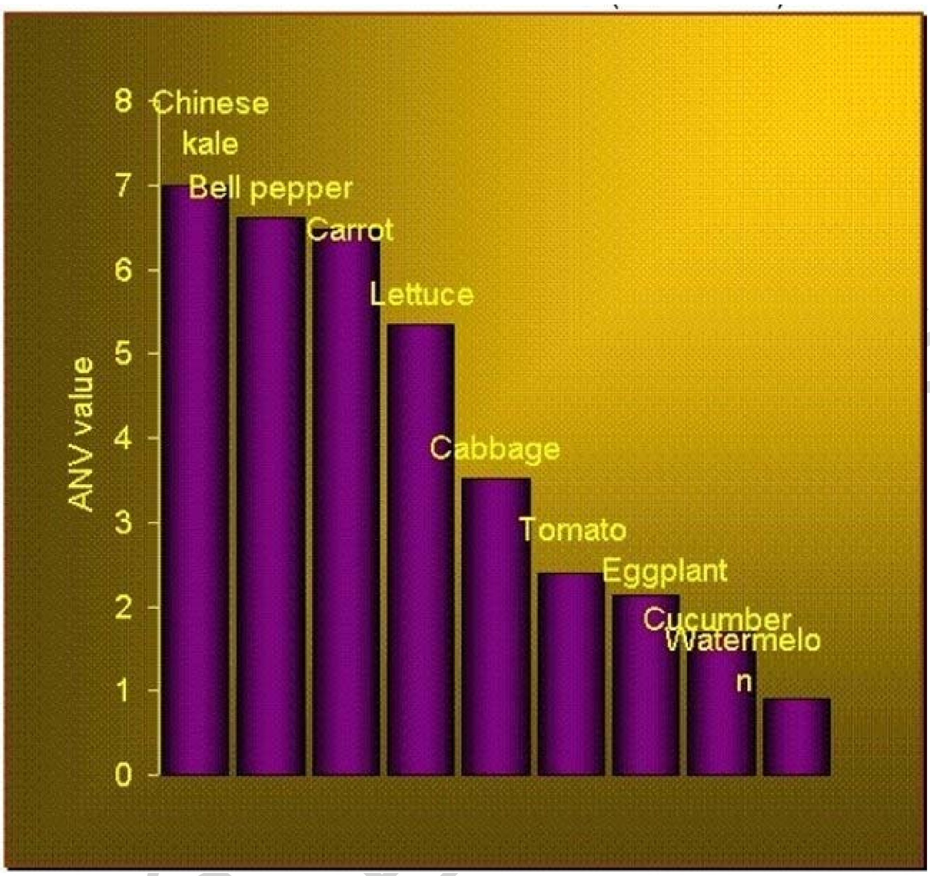

Figure 4: Average nutritive value of various vegetables

Main nutrient constitution of the vegetable green pepper is shown in Table 2.

Dry matter	6600-14500	Potassium	186-212	Vitamin C	60.0-250.0
Carbohydrate	2400-7100	Calcium	9-13	Thiamine (B1)	0.06-0.10
Proteins	700-3800	Magnesium	1-12	Riboflavin (B2)	0.04-0.08
Fat	200-1800	Phosphorus	22-30	Niacin	0.10-0.30
Pectin	200-600	Iron	0.4-1.0	Pantothenic	0.10-0.15
Cellulose	300-2300	B-carotene	0.20-0.60	Vitamin B6	0.10-0.15

Table 2: Nutrient contents in green pepper (mg per 100 g fresh mass) (Source: Győri 1999)

Vitamin C content may reach 250 mg per 100 g fresh tissue in green pepper, which easily cover the daily demand of an adult. There are some effects of the variety and the growing conditions on vitamin C content as follows: vitamin C concentration is higher in green varieties with smaller fruits, than white or light green ones with bigger fruits and thick wall. Additionally to vitamin C there is about 0.2 mg% of niacin (vitamin P), which can enhance the beneficial effects of vitamin C. Thiamine and riboflavin concentrations are also high enough to cover the one-day demand of an adult.

Carotene content may be almost as high in ripe yellow and red fruits as in carrots, but much lower in the green varieties. Ripeness of the marketed fruit is important when focusing on vitamin content. Green peppers are mostly harvested and marketed in a pre-ripe stage, when they are still green or light green. In full ripeness, their colour is either red or yellow or possibly blackish-bluish dark green, depending on the variety. Carotenes are most abundant in the fully coloured fruits, whereas vitamin C content is the highest in the marketed, pre-ripe stage, and gradually decreases until full ripeness.

Thiamine (vitamin B1) content of the food pepper is breaking down while cooking, but riboflavin (B2) enhances iron and zinc bioavailability for the consumer in hot dishes too.

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Bibliography

http://ashs.frymulti.com: The website of the American Society for Horticultural Science. (ASHS Journals Online. Also there is an internet resource portal, over 260,000 pages of information from every lad-grant university of the USA an some institutions from Canada.)

AVRDC Reports, 1999 and 1999: Reports of AVDRC activities on research and education in Asian, African and South American countries. (Reports on various techniques of vegetable production, crop diversification, socio-economic studies, evaluation of bioavailability, disease resistance, and special projects, as well as reports on demonstrations, workshops and other meetings wits local farmers.)

Balázs S. 1994. Handbook for vegetable growers. (In Hungarian). Mezőgazda, Budapest, Hungary

FAO homepage: http://www.fao.org (Among a host of possibilities the statistical databases of FAOSTAT also can be reach)

Győri, Z.1999. Crop quality as influenced by nutrient supply. (In Hungarian). In: Füleky Gy. (ed.) Nutrient economy. Mezőgazda, Budapest, Hungary. Pp. 560-673.

Harlan J. R. 1975. Crops and Man. Am. Soc. of Agronomy, Crop Sci. Soc. of America, Madison, Wisconsin. 279 pp. (The history of domestication of various crops is discussed in this book.)

Hortivar: http://www.fao.org/hortivar :a FAO database on the performance of cultivars, cropping and yield, conditions and practices, etc.

http://www.ishs.org : website of International Society for Horticultural Sciences. (This site is served as a knowledge bank and interactive learning centre on identification, care, cultivation and utilisation of plants with the links to Purdue University and Ohio State University. Links also to Acta Horticulturae hompage where one can browse among the publications, proceedings of international symposiums on various topics of horticulture issued by the Acta Horticulturae.)

http://www.new-agri.co.uk : website of the journal New Agriculturist (with interesting new topics, many brief news, country profiles, etc.)

Proc. Int. Symp. on Brassicas. Eds.: Thomas Grégoire and Antonio A. Monteiro Acta Hort. 459. ISHS 1998.

Proc. III. Int. Symp. on Brassicas. Ed.: G. J. King. Acta Hort. 539. ISHS 2000.

Proc. Int. Symp. on Quality of Fresh and Fermented Vegetables. Eds: J. M. Lee et al. Acta Hort. 483. ISHS. 1999.

Biographical Sketch

Krisztina R. Végh is a research worker in the Research Institute for Soil Science and Agricultural Chemistry of the Hungarian Academy of Sciences (RISSAC) Budapest, Hungary. She completed her MSc in Biology in Budapest Science University (ELTE) Hungary. Her PhD thesis analysed the nutrient dynamics in the rhizosphere, by using measurements and modelling. Her interests also include system modelling in sensitive environments, in drought-prone areas, and, in nutrient deficient conditions. She has conducted several research projects on plant nutrition, water use and drought tolerance, and cooperated in both Hungarian and international research. She has worked in Uppsala, Sweden, in Tokyo, Japan, and now she works in joint projects on sustainable plant nutrition, together with Indian universities and research institutes.