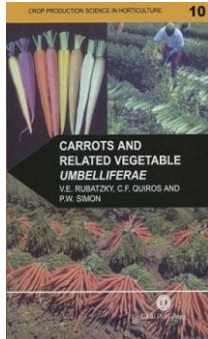


## Main characteristics and cultivation of carrot



### Nutritional value

- Very favourable nutritional quality; high ANV value
- 4-10% sugar content; 1% protein
- 1% ash - essential mineral nutrients
- 1% dietary fibre Dietary roughage
- Vitamins: provitamin A carotenoids (6-54 mg/100 g), vitamin C thiamin, riboflavin, niacin, folic acid
- Pigments ↔ root colour;  $\alpha$ - and  $\beta$ -carotene (orange), (orange), xanthophyll (yellow), lycopene (red), anthocyanin (purple)
- Phenolic compounds (chlorogenic acid)
- Volatile terpenoids → unique flavour
- Nitrate accumulation

### Importance

- The only vegetable umbellifer with nearly worldwide distribution
- FAOSTAT statistics (Carrots and turnips) 2016:
- **World:**
- 1,17 M ha, 42,7 M t, 37 t/ha
- China 47%, Uzbekistan 5.3%, Russia 4.3%, USA 3.3%
- **EU:**
- 131 th. ha, 5,9 M t, 45 t/ha
- Poland 14%, UK 13.8%, Germany 11%, France 9.9%, The Netherlands 9.2%, Italy 9.1%,

## Taxonomy and origin

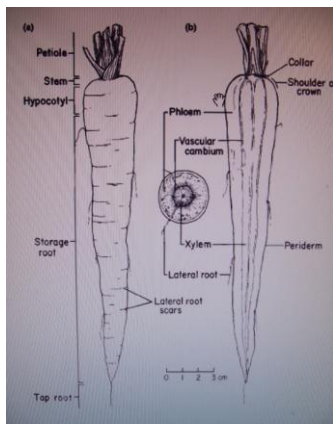
- *Apiaceae* family (250 genera, 2800 species) – herbaceous plants from temperate and boreal regions
- *Daucus* genus (25 species)
  - *Daucus carota*
- Progenitor is the wild carrot (*Daucus carota* var. *carota*)
- Originated from the Asia Minor region (Turkey)
- Cultivated in Europe from the 12th century
- Orange carrot since the 18th century (the Netherlands)

### Usage

- Grown for its edible storage root
- Eaten raw in salads, used as a snack, however usually consumed in cooked forms (in soups, garnish, etc.) - all year round consumption
- Fresh products: bunched roots, bulk whole carrots without tops, polyethylene film pre-packed; fresh carrot pieces: baby, cut and peel carrots
- Processing: canned (diced pieces, slices, intact small roots), frozen, dehydrated (chips, flakes, powder), puréed (infant food), pickled, juice products
- Raw product for carotene extraction
- Its calorie production/area/day is among the highest → biomass source?

### Morphology

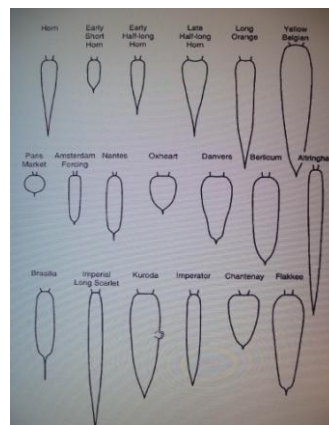
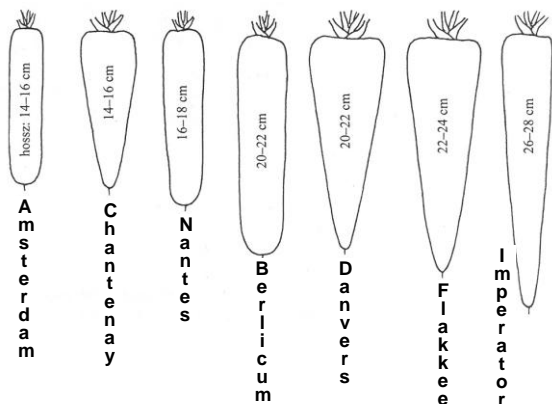
- Biennial plant
- **Root system:** enlarged fleshy storage taproot; (5)-10-25-(50) cm length, 2-10 cm diameter; high phloem to xylem ('core') ratio is favourable; similar phloem, cambium and xylem colour is favourable
- **Stem:** greatly compressed, internodes are not clearly recognisable
- **Leaf:** in basal rosette; 2-3 pinnate, pinnatifid leaflets
- **Inflorescence:** on high inflorescence stalk (60-200 cm), composed of many umbels
- **Flower:** small, bisexual perfect, white,
- **Fruit (seed):** a schizocarp consisting of two mericarps, which are the achenes – the seed (2 g thousand seed weight)



/Rubatzky et al./

## Classification of cultivars

- Mainly hybrids are grown
- **Based on ecological needs:** temperature and subtropical carrots
- **Based on the production regions:** eastern/Asiatic types (pubescent, reddish purple or yellow) and western carrots
- **Based on root shape/rate of growth:** Paris Market, Oxheart, Amsterdam, Nantes, Berlicum, Imperator, Chantenay, Danvers, Flakkee; (conical, cylindrical, round)
- **Based on root colour:** Orange, yellow, white, red, purple
- Maturity period ↔ root size, yield potential, dry matter content, usage



/Rubatzky et al./

## Ecological requirements I

- **Light:** more productive in full light; light can induce chlorophyll (shoulder greening) or anthocyanin accumulation in the upper part of the roots
- **Temperature:** cool season crop; optimal growing temperature is 15-21°C, less than 10 and more than 25°C mean temperatures limit growth; has some frost tolerance; 25°C is optimal for germination
- 10-15°C results the best root quality, higher temperature results in shorter and thicker roots;
- expanded period under 10°C can result bolting due to vernalisation

## Ecological requirements II

- **Water:** intolerant of waterlogging; rapid change in soil moisture content induce root splitting; proper seedbed moisture is crucial for good germination
- **Soil:** the key ecological factor for carrot production; loam/sandy loam, friable, moist, well-drained soil is required; well-drained organic soils are excellent for fresh market carrot production; sandy soils are suitable for early cropping
- pH can vary between 5,0-8,0 with 6,0 as optimal value; moderately sensitive to salinity
- **Nutrients:** moderate nutrient requirement; excessive N fertilization results in high nitrate content; K has a key role in sugar and carotenoid synthesis, high requirement for calcium

### Production method I

- **Crop rotation:** should not follow other umbellifers and root crops; once in every four years
- **Tillage:** crucial importance; deep ploughing to depths of 40-50 cm, well-prepared seedbed is required (small seeds, field germination is slow); avoidance of soil crusting during the emergence
- production on raised beds is getting the standard procedure; raised beds improve drainage and soil aeration;
- **Propagation:** always direct seeded; shallow sowing; twin rows for raised bed (70-100 + 10-20 cm); row distance is 35-50 cm for single rows;
- plant density is  $\leq 1,2$  million for large rooted, and 1,75-2,5 million for small rooted cultivars; thinning is not practiced
- Enhancing earliness with temporary covering

### Production method II

- **Weeding:** carrot seedlings are poor competitors, cultivation is difficult at later growth stages, selective herbicides are used complemented with manual removal and hoeing
- **Irrigation:** adequate soil moisture is a critical requirement during seed germination, sprinkler irrigation is the best for providing good germination; irrigations at 7-10 days intervals
- **Fertilization:** 60:30:125 kg NPK/ha is a typical recommendation
- **Harvest:** 70-150 days after seeding; do not have a defined maturity stage, often is harvested before achieving its full potential size; yield is 30 (early, small rooted) to 100 (late, big rooted) t/ha
- hand digging in smallholdings; it can be mechanized: modified potato harvesters, top lift type of harvesters.

### Production method III

- **Post-harvest:** cleaned, (trimmed), washed, graded, low-temperature pre-conditioning before storage
- bunched carrots 2 weeks at 0°C and 100% rh; topped carrots in plastic bags for 1-2 months at 0°C and 98-100% rh
- **Storage:** long-term post-harvest storage is still an important practice in Europe
- in situ, overwintering storage – soil cover, straw mulching; field clamps, ground storage pits; common storage; controlled-temperature storage;
- usually not washed before storage; stored in bulk piles or in large bins