Mom! Wren's eating a piece of broccoli! She found under the table!

What? You're kidding!

I feel like an idiot.

Shh! I think she's about to try the spinach!
Mustard Crops

Origin and Domestication

Wild relatives include mustards, kales, and other non-heading cabbages

Center of origin – species dependent; southern Europe, Mediterranean region, Asia, Africa

Many crops still resemble their respective wild types
Brassica Crops

Family – Brassicaceae (commercially important)

*B. nigra* – black mustard

*B. oleracea* – (cole crops) cabbage, broccoli, cauliflower, kale, brussel sprouts, kohlrabi

*B. rapa* – turnip, Chinese mustard, turnip rape, broccoli raab, Chinese cabbage

*B. carinata* – Abyssinian mustard

*B. juncea* – various forms of mustard

*B. napus* – rutabaga, Siberian kale, oil rape, canola
(Brassica nigra)
Black mustard

The traditional source of seeds used for making condiment mustards
*(Brassica oleracea)*

Most widely grown group. Includes what we call the Cole Crops (cabbage, broccoli, cauliflower, brussels sprouts, kohlrabi, etc)
(Brassica rapa)

Includes many important Asian crops, including Pak Choi and mizuna. Also the source of turnips.

Chinese mustard
Tat-soi

Used as a pootherb
(Brassica carinata)

Abyssinian mustard

Grown in limited areas of East Africa. Used as a potherb and for industrial seed oil (glucosinolates).

Drought tolerant.
(Brassica juncea)

Edible mustards

Widely used in Asia. Wide range of heading and leafy types. Used as potherbs and vegetable greens.
(Brassica napus)

Includes rutabaga, siberian kale, and rapeseed. Critical source of culinary seed oil
FIG. 19.1. Genomic interrelationships among *Brassica* species as proposed by U in 1935.

Brassica genetic relationships
Cole Crops

Origin and Domestication

Wild relative thought to be seakale

Center of origin – southern Europe and the Mediterranean region

First domesticated types were annual, and non-heading

All cultivated types arose as mutants or selections
Cole crop relationships
Cole Crops

Crop relationships

*Brassica oleracea* cultivar groups:

Acephala group – kale
Alboglabra group – Chinese broccoli (kailan)
Botrytis group – cauliflower
Capitata group – cabbage
Gemmiferae group – Brussels sprouts
Gongylodes – kohlrabi
Italica – sprouting broccoli (calabrese)
Cole Crops

Crop relationships

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**Alboglabra group** – Chinese broccoli (kailan)
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Cole Crops

**History and Domestication**

Evidence of non-heading forms used in 2500 BC

Kale – described by Theophrastus in 350 BC

Kohlrabi possibly appeared around 1 AD

Soft-head cabbage – described by Pliny in 1 AD

Broccoli – imported into Rome around 400-600 AD

Cauliflower first described in 1544 AD

First written description of Brussels sprouts in 1587
Cole Crops

Characteristics - Nutrition

Low in carbohydrates, fats, calories

Good source of protein (balanced), minerals, vitamin A, vitamin C, other vitamins

Known anticancer properties

Includes antioxidants – ascorbic acid, tocopherols, carotenoids, isothiocyanates, indoles, flavanoids
Cole Crops

Toxicity

Contain glucosinolate compounds
  Converted to: isothiocyanates, thiocyanates, nitriles, goitrin

Interfere with thyroxine production

Associated with goiter (thyroid enlargement)

Low glucosinolate varieties are common
Cole Crops

Production – Soils and Climate

All cool-season, hardy crops, frost tolerant

Prefer cool, moist climates (cabbage widely adapted)

Dry conditions enhance petiole growth, fibrousness

Heat causes strong flavors

Requires consistent water availability

Can be grown on any type of soil
Cole Crops

Production – Propagation and planting

Seed propagated
  Direct seeded
    Short season crops (kohlrabi, kale)
    Cabbage, broccoli, cauliflower for processing

Transplanted
  Crops for early harvest, garden production
  Expensive hybrid seed
Hollow stem in broccoli – boron deficiency
Cole Crops

Production – Buttoning and blindness

Premature initiation of heads or inflorescence

Results in low yield, small unmarketable product

Caused by growth disruption due to:

- Low nitrogen
- Low soil moisture
- Low temperature (if plants are past juvenile – ¼” stems)
- Other causes
Buttoning vs normal broccoli
Vernalization requirements of cole crops

<table>
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<tr>
<th>Crop</th>
<th>Harvested portion</th>
<th>Flowering</th>
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<tbody>
<tr>
<td>Broccoli, early type</td>
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<tr>
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<tr>
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<tr>
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<tr>
<td>Cauliflower, early type</td>
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<tr>
<td>Cauliflower, tropical type</td>
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<tr>
<td>Chinese broccoli</td>
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<tr>
<td>Collards</td>
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<tr>
<td>Kale</td>
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</tr>
<tr>
<td>Kohlrabi</td>
<td>No</td>
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</tr>
</tbody>
</table>
Clubroot in cauliflower (caused by *Plasmodiophora brassicae*)
Cole Crops

Production – Harvest

Each crop has specific harvest indices

Harvest interval varies widely with crop

Most are hand harvested (machine assisted)

Immediate cooling usually required

Field trimming and/or packing is common
Cole Crops

Handling and Storage

Cooled w/ water, ice or room-cooled

Commonly stored at 32 degrees, 98-100% RH

Storage life varies by crop

CA storage effective for some crops

Ethylene causes senescence and injury
Cole Crops

Organic Production

Not recommended in many areas – pest issues

Imported cabbageworm

Diamondback moth

Cabbage aphids

Root maggots
Ol’ King Cole declared the only acceptable way to eat cabbage is shredded and mixed with mayonnaise and bits of carrots. By what name is this decree known?
Ol’ King Cole declared the only acceptable way to eat cabbage is shredded and mixed with mayonnaise and bits of carrots. By what name is this decree known?

Cole’s Law
Cabbage
Cabbage

Worldwide Production

Major producing areas, China, India, northern Europe, North America

Common in modern-intensive, market garden, and subsistence systems

Historically very important in Slavic countries
Cabbage

Varieties

Classifications:
- Early, midseason or late
- Red or green
- Smooth or savoy
- Fresh or kraut
- Hybrid or open-pollinated
Cabbage

Food Uses (Cultural)

Salads/coleslaw - North America

Soups – Europe, Russia (borscht)

Pickled – Asia (e.g. kim’chi)

Stir fried on rice – Asia

Sauerkraut – Northern Europe
"Broccoli is biodegradable, you know, in case you want to throw it out before I eat it."
Broccoli
Broccoli

Major producing countries

Historically considered an exclusively Italian vegetable

First U.S. crop in 1923 in California

Current U.S. production on over 120,000 acres

China (9M tonnes) and India (6.7M tonnes) lead worldwide production, with Spain (528K tonnes), Mexico (428K tonnes), Italy (421K tonnes) (334K tonnes), and France having greater production than U.S. (325K tonnes)
Broccoli

Varieties

Biennial types
- Purple sprouting (overwintered, branching)
- Purple cape (overwintered, single head)
- White sprouting (overwintered)

Annual type
- Calabrese (spring, single head) prominent type

Romanesco (cauliflower???)
- Natural fractal geometry, number of buds a Fibonacci #
Broccoli

Harvest

Harvest indices
Compact head
No open inflorescences

Head plus 8-10 in of stem harvested

Hydrocooled immediately and packed in ice
Broccoli

Broccoli - overmature
Cauliflower
Cauliflower

Varieties

White curd
   Snowball, Erfurt, Snowcap

Purple curd
   Early Purple Head

Both annual and biennial varieties are used
Cauliflower

Production Practices

Blanching:

- Flavor problems and yellowing with light exposure
- Leaves are tied over curds with strings or rubber bands
- Blanching should begin about 1 week before harvest
- Self-blanching varieties becoming more common
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<td>PEAS</td>
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</tr>
<tr>
<td>CABBAGE</td>
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<tr>
<td>LIMA BEANS</td>
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<tr>
<td>Brussels Sprouts</td>
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</tr>
</tbody>
</table>
Brussels Sprouts
Brussel Sprouts

Major producing countries

United Kingdom
Netherlands
Belgium
Other European countries
Australia
United States
(Of minor importance outside Europe)
Brussel Sprouts

Varieties

Dwarf Varieties (< 20 in tall)
  Improved Long Island, Catskill Jade Cross (hybrid)

Tall Varieties (>20 in tall, popular in England)
  Irish Elegance, Sherradian, Breda
Kohlrabi
Kohlrabi

Types

White tuber
Green tuber
Purple tuber

Consumer Use

Considered a staple crop in the Kashmir region of India and Pakistan
Kale/Collards

Description

Kale is a green (boiled pothouse like spinach)

Grown only for leaves (non-heading, non-flowering)

Ornamental cabbage is a form of kale

Collards are a type of kale with cabbage-like leaves

Kale grown in Europe, Asia

Collards popular in southern Europe, Africa, southeastern U.S., and Caribbean
Kale - Redbor
Kale – Red Winter
Kale – Ornamental Cabbage
Collards
Mustard Greens

Description and production

Large group of mustard crops grown as potherbs

Most belong to *B. rapa* or *B. juncea*
- Chinese mustard (grown primarily in China)
- Mizuna (grown primarily in Japan)
- Charlock (grown mostly in the Mediterranean)

Grown, harvested, and marketed like collards
Chinese Mustard
Purple-leafed Mustard
Charlock Mustard
Chinese Cabbage (napa cabbage)

Description and production

Two sub-species
- *B. rapa* ssp. *pekinensis* (pe-tsai) – compact head, like Romaine lettuce
- *B. rapa* ssp. *chinensis* (pak-choi) – loose head, like swiss chard

Of major importance in Korea and China

Becoming popular in Europe and the United States

Used like lettuce and cabbage, making of kim’chi
Chinese Cabbage – Pe-tsai Type
Chinese Cabbage – Pak-choi Type
Turnip

Description and production

Species *B. rapa* ssp. *rapifera*

Leaves used as a potherb

Mostly grown for fleshy root

Root prepared boiled, fried, roasted

Harvest when <6 in diameter for best quality

Historically an important European survival crop
Rutabaga

Description and production

Species *B. napus var. napobrassica*

Similar to turnips in use, flavor, production.

Flavor improves following cold weather

Can be stored for very long periods of time

Most production and consumption in Europe

Rutabagas carved for Halloween in Scotland
Horseradish

Description and production

Species: Armoracia rusticana

Native of SE Europe

Hardy perennial

Root used to make relish

Flavor due to allyl isothiocyanates

Produced in US, Europe, Australia

Collinsville, Illinois – horseradish capital of the world