

# Space Colonial Farming

Achan Aeronautics and Space Society



Department of Agriculture

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## Preface

This summary is a typeset version of five separate imageposts by an anon for the /sfg/ Space Flight General thread on /sci/ primarily regarding the topic of the species of plants, animals, fungi, and bacteria that may be utilized in a spaceflight or off-world colonial setting. Good efforts, anon. *Salire Ferociter.*

Anonymous

# 1 Hydroponics



Figure 1: Examples of hydroponics setups

- Very efficient and can utilize fish waste directly with an aquaponics setup
- Up to 10 to 50 times higher yield per area ratio than soil
- No pests, weeds, or seasons
- Can be automated
- Dwarf varieties can be grown with higher yields and smaller footprint
- Can grow varieties unsuitable for conventional fields, such as those easily overtaken by weeds or can not be combine harvested

## 1.1 Lettuce



Figure 2: Lettuce in hydroponics

- Basically no waste
- Fast growth
- Many varieties

## 1.2 Potato



Figure 3: Potatoes

- The second highest caloric yield after sweet potato
- Can be grown hydroponically
- Can grow in very poor soils, even in regolith

### 1.3 Sweet Potato



Figure 4: Sweet potatoes

- The highest caloric yield of all crops
- Lot of beta-carotene
- Grows as a vine
- Usually grows thin tubers in hydroponic setups

### 1.4 Perigee Wheat



Figure 5: Perigee wheat

- Specifically cultivated for space hydroponics
- Has actually been tested on the ISS
- Does not mind constant light without night-cycle
- From seed to harvest in 60 days
- Amount of grain per plant is actually slightly higher than normal plant
- 4 times higher yield than normal wheat
- Stackable

### 1.5 Super Dwarf Rice



Figure 6: Super Dwarf Rice (right)

- Same benefits as Perigee wheat
- One fifth the length of standard rice about 20 cm tall
- Higher protein content than normal rice

### 1.6 Tomatoes



Figure 7: Genetically engineered tomatoes

- Genetic modification doubles yield
- Minimized stems and branches

## 1.7 Soy



Figure 8: Soybean plant

- The only plant with all essential amino acids
- Milk and meat substitute
- Estrogenic isoflavones can be removed
- Micro-filtration of the juice removes 80% of isoflavones
- Prolonged cooking removes up to 90% isoflavones
- Hydroponically-grown soy has only 30% isoflavones compared to soil-grown
- Relatively simple genetic modification could remove isoflavones entirely

## 1.8 Maca



Figure 9: Macas

- Extremely hardy plant –needs low temperatures
- Nutritionally comparable with potatoes
- Slower growth
- Helps deal with low oxygen, low pressure of Andes
- Reduces muscle fatigue
- Reduces anxiety and depression

## 2 Fruit Trees

- If greenhouses are big enough, trees are good for variety and are relatively low maintenance
- Trees are generally unsuited for hydroponics (although it is possible)
- Tropical fruit trees have faster metabolism and the highest yields
- Dwarf varieties preferred due to limited space

### 2.1 Bananas and Plantains



Figure 10: Different types of bananas and plantains

- Many varieties besides regular Cavendish
- Some even taste like strawberry cake or vanilla ice cream
- Some are more like potatoes –starchy, and needs to be cooked
- Caloric yield/area comparable with potatoes

### 2.2 Papaya



Figure 11: Papaya

- Not actually a tree –oversized stalk
- Seeds can be used in place of black pepper, which takes 5 years to produce spice
- Papaya bears ripe fruit in only 10 months

### 2.3 Breadfruit



Figure 12: Breadfruit

- Unripe and roasted breadfruit tastes like bread
- Ripe breadfruit tastes like green mashed potatoes
- Very high caloric yield/tree
- Related to jackfruit

### 2.4 Citrus Trees



Figure 13: Citrus fruit

- Even small shrubs can have a decent yield
- Mostly for condiment

## 2.5 Moringa



Figure 14: Moringa tree

- Extremely fast growing tree (2ft/month)
- Every part is edible
- Leaves are like tiny cabbage leaves and are high in protein
- Pods are like giant string beans
- Flowers taste like berries
- Ripe seeds are rich in oil, similar to peanuts
- Root is like horseradish

## 2.6 Jackfruit



Figure 15: Jackfruits

- Highest yield of all fruit trees
- Ridiculously huge fruit –up to 30 kg each
- Ripe fruit tastes like pineapple/banana mix
- Unripe fruit is used as fake meat
- Seeds are edible and taste like chestnuts
- Rich in latex
- Considered poverty food in India due to its abundance

### 3 Livestock

- Very efficient and can utilize fish waste directly with an aquaponics setup
- Up to 10 to 50 times higher yield per area ratio than soil
- No pests, weeds, or seasons
- Can be automated
- Dwarf varieties can be grown with higher yields and smaller footprint
- Can grow varieties unsuitable for conventional fields, such as those easily overtaken by weeds or can not be combine harvested

#### 3.1 Guinea Pigs



Figure 16: Guinea pigs

- Taste is cross between duck and rabbit (allegedly)
- Can digest cellulose, such as straw, stalks, and leaves
- Does not mind small enclosures
- Large litters, 3 months to good size

#### 3.2 Vietnamese Pigs



Figure 17: A Vietnamese pig

- Well behaved
- Omnivorous, can eat almost anything
- Can partially digest cellulose
- Most compact of red meat livestock
- Reaches adulthood in 6 months

#### 3.3 Tilapia



Figure 18: Tilapia

- Freshwater fish common in aquaponics
- Is mostly a herbivore
- Takes 6 months to grow
- Does not need much space
- Excretes ammonia to fertilize hydroponic plants directly
- Does not mind warm water

#### 3.4 Prawns



Figure 19: Prawn

- Live in fresh water
- Propagate in salt water –easier to control population within system
- Fed with granulated algae and cereal bran
- Like tilapia, can be used in aquaponics
- Take about 6 months to grow to full size

### 3.5 Broiler Chicken



Figure 20: Broiler chicken

- From egg to fully-grown mass of 2 kg in 60 days
- 1.5 kg of feed produces 1 kg of meat (under ideal conditions)
- Not the ideal breed for egg production, but certainly possible
- Omnivorous –can eat plants as well as scraps and offal
- Cannot digest cellulose

## 4 Fungi

- Capable of processing excess cellulose
- Straw and husks are first dried and steamed
- Media is inoculated in sterile environment
- Susceptible to contamination
- Beta-glucans boost immune system, acts as an anti-carcinogenic agent

### 4.1 Shiitake



Figure 21: Shiitake mushroom growing

- Smoky and earthy taste
- Prefers hardwood, can grow on straw

### 4.2 Enoki



Figure 22: Enoki mushroom

- Crunchy and slightly sweet
- Can be eaten raw
- Grows on straw/sawdust substrate
- Low-oxygen atmosphere improves quality

### 4.3 Champignon/Portobello



Figure 23: Champignon mushroom growing

- Prefers manure-based substrate with straw

### 4.4 *Fusarium venenatum* - Quorn

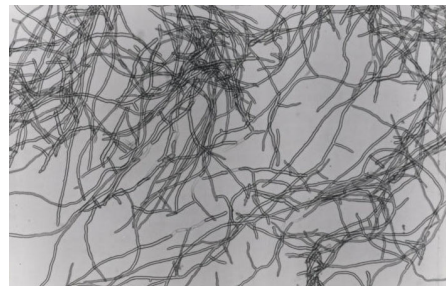


Figure 24: *Fusarium venenatum* under microscope

- Filamentous mold
- Grown in a fermentation reactor from glucose
- Strained biomass is mixed with binder (eggs or other protein) and turned into a meat substitute
- Hyphae (filaments) are very similar in size and toughness to muscle fibers –results in similar texture
- Some people are allergic

## 4.5 Oyster



Figure 25: Oyster mushrooms growing

- Very mild taste
- Several different varieties exist.
- Needs to be cooked
- Prefers straw/bagasse

## 5 Algaculture

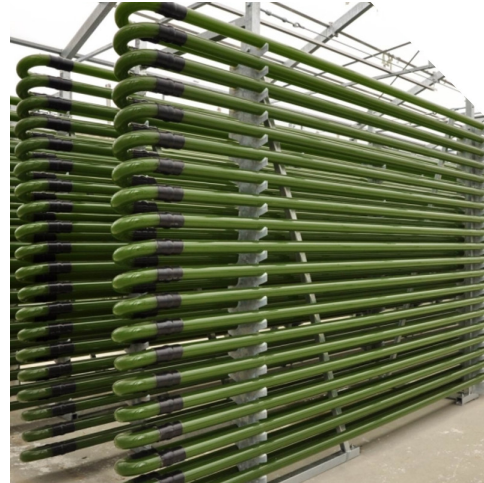


Figure 26: Algae bioreactors

- Produces large amounts of oxygen
- 4x higher photosynthetic efficiency than plants
- Needs only pre-heated CO<sub>2</sub> from atmosphere and some minerals
- Usable for animal feed
- Can be pressed into cooking oil

### 5.1 *Neochloris oleoabundans*

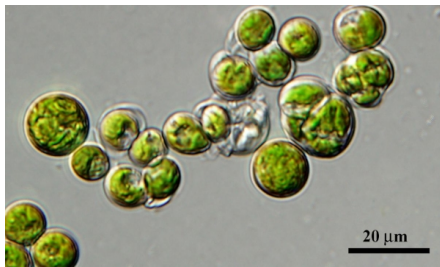


Figure 27: *Neochloris oleoabundans* cells

- Lipids make up 35–55% of its dry weight
- Oil production is 150 mg per liter per day
- 1 tank produces 55 L of oil per year

### 5.2 *Arthrospira*

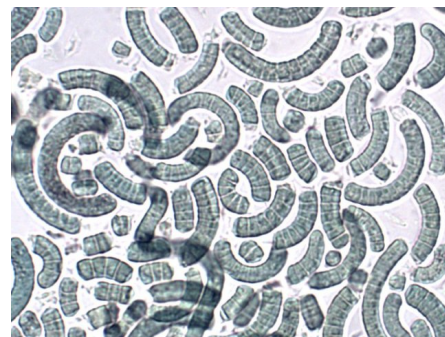


Figure 28: *Arthrospira* cells

- Proteins make up 55-65% of its dry weight
- Excellent for animal feed
- Supplementing more than 20% of diet can cause health issues (gout)

### 5.3 *Porphyridium cruentum*

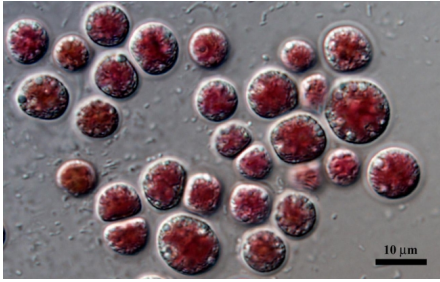


Figure 29: *Porphyridium cruentum* cells

- Hydrocarbons make up 35–55% of its dry weight
- Can be fermented for alcohol/acetic acid
- Excellent emulsifier

### 5.4 *Haematococcus pluvialis*

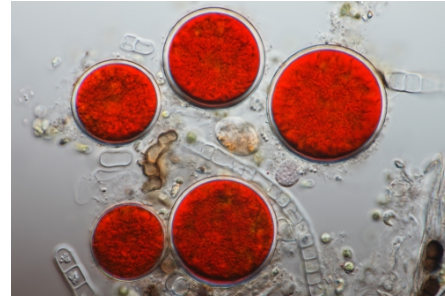


Figure 30: *Haematococcus pluvialis* cells

- When deprived of nutrients, it produces astaxanthin
- Powerful antioxidant carotenoid
- It is what gives shrimp flamingos red/pink color

## 6 Utility/Feed Plants

### 6.1 Russian Dandelion (*Taraxacum kok-saghyz*)



Figure 31: Dandelion plants (left) and roots (right)

- Contains large amounts of latex
- Identical to rubber tree latex
- Attempts to cultivate during WWII, went nowhere after it
- 1/2 of deep root mass is lost in traditional harvest methods
- Hydroponics recovers 100%
- Rubber tree takes 7 years to harvest while dandelions need less than a few months
- Root also contains a lot of inulin –used as prebiotic
- The leaves and flowers are edible

### 6.2 Loofah



Figure 32: Loofah fruits (left) and fibrous interior (right)

- Young fruits are like zucchini
- Mature fruits turn fibrous –can used as a scrubbing sponge
- Used as a vegetable or for cleaning

### 6.3 Bamboo



Figure 33: Bamboo shoots

- Fastest growing plant
- C<sub>4</sub> metabolism –up to 2x more effective at CO<sub>2</sub> processing
- Shoots are edible
- Can be processed into fibers and cloth
- Can be ground up for filler material in 3D printing
- Used as a wood substitute indoors
- Leaves can be use as animal feed (like grass)
- Can be pyrolyzed for charcoal –used as filtration medium

## 6.4 Sugarcane



Figure 34: Sugarcane plants

- Extremely high yield
- $C_4$  metabolism
- Easy source of sugar with only little processing
- Leftover bagasse can be dissolved
- Cellulose can be chemically processed into plastic and textiles
- Cellulose can also be hydrolyzed for even more glucose
- Tops are good animal feed

## 7 Textiles and Biopolymers

### 7.0.1 Rayon/viscose

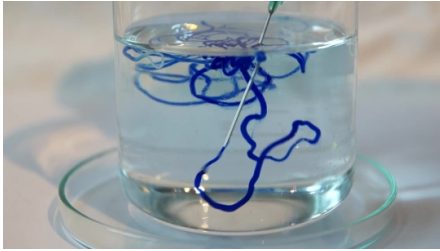


Figure 35: Formation of rayon by polymerization of viscose in sulfuric acid

- Cellulose is dissolved in lye and re-precipitated into yarn
- Any cellulose-based material works in principle, such as wood, straw, bamboo
- Solution is extruded into fiber for fabrics –chemically identical to cotton
- Adding glycerol results in cellophane plastic
- Chemicals used can be regenerated

### 7.0.2 Scoby Leather



Figure 36: Preparation of scoby leather

- Symbiotic colony of bacteria/yeast
- Grows by fermenting sugar
- Growth medium is drinkable (Kombucha, Kefir)
- Extremely simple to cultivate
- Thick enough layer can be dried, oiled and used in place of leather or parchment
- Tanning these “hides” still needs to be perfected –result is semi-transparent “rawhide”
- Edible

### 7.0.3 Cellulose Acetate



Figure 37: Cellulose fabric samples

- Production process similar to viscose
- Acetic acid bonded in structure changes properties
- Thermoplastic –meltable and moldable (viscose is not)
- Fibers are more absorbent and better isolating
- Can be spun into a soft fabric or fake silk
- Can be molded into hard clear “vintage plastic”

### 7.0.4 Lignin



Figure 38: Lignin sample and 3D-printed part composed of lignin-nylon-carbon fiber composite filament in beaker

- Second main component of plants after cellulose
- Plain lignin can be added to animal feed as a supplement
- Leftover after dissolving cellulose
- Can be processed to plastic similar to ABS –replacing styrene
- Better mechanical properties than ABS
- Can be added to rubber, improving stability

## 8 Kitchen and Medicinal Garden/Park

- Spices and herbs can be grown in soil or hydroponically
- Once the colony gets big enough, some public space can be set up as parks with decorative plants
- Plants still should have some practical use other than to just look nice, be it culinary or medicinal
- Antioxidant-rich diet can protect against radiation damage, resulting in a lower cancer rate
- Antioxidants by themselves do not cure cancer and radio-protective effects conflicts with radiotherapy

### 8.1 Culinary

#### 8.1.1 Canna (*Canna Indira*)



Figure 39: Canna flowers (left), bulb (upper right), seeds (lower right)

- Popular decorative plant
- Rhizoid has high quality starch content
- Starch is also used for making glass noodles
- Leaves can be made into paper
- Shoots can be eaten as vegetable
- Unripe seeds can be ground to flour

#### 8.1.2 Marsh Mallow (*Althaea officinalis*)



Figure 40: Marsh mallow flower

- Root extract can be used as egg whites
- Anti-cough effects

#### 8.1.3 Passionflower (*Passiflora edulis*)



Figure 41: Passionflower

- Grows as a vine
- Antioxidant properties
- Ripens to passion fruit

#### 8.1.4 Ginger, Galangal (*Zingiber officinale*, *Alpinia spp.*)



Figure 42: Flowers of different varieties of ginger

- Treats nausea
- Antioxidative
- Several related genuses
- Variety of flowers and tastes
- Juice can be used as rennet for cheesemaking

### 8.1.5 Garlic, Onion (*Allium spp.*)



Figure 43: Garlic flower

- Slightly lowers blood pressure
- Antibiotic
- Decreases cancer risk

### 8.1.6 Peppers (*Capsicum spp.*)



Figure 44: Peppers

- Improves heart function
- Antimicrobial
- Treats osteoarthritis
- Decreases cancer risk

### 8.1.7 Rosemary (*Salvia rosmarinus*)



Figure 45: Rosemary plant and flowers

- Antimicrobial properties
- Increases effect of vitamin E

## 8.2 Park Shrubs and Trees

- Shrubbery that acts like a spice or medicine

### 8.2.1 Willow (*Salix spp.*)



Figure 46: A willow tree

- Source of salicylic acid
- Used for skin conditions
- Simple reaction makes aspirin (acetylsalicylic acid)
- Young branches can be used for wicker
- Fast growth rate –up to 8 ft per year

### 8.2.2 Ginkgo (*Ginkgo biloba*)



Figure 47: A ginkgo tree

- Tea helps with blood circulation
- Rich in antioxidants
- Extract is measurably radioprotective

### 8.2.3 Java Plum (*Syzygium cumini*)



Figure 48: Java plum fruit

- Fruit tree similar to small plums
- Rapidly growing, invasive in some places
- Among the highest antioxidants content of fruits
- Radioprotective
- Lowers blood sugar level, seeds especially
- Used to treat diabetes

### 8.2.4 Tea (*Camellia sinensis*)



Figure 49: Tea plants

- Improves concentration
- Antioxidative and other health benefits
- Look up Laszlo Montgomery's History of Tea

### 8.2.5 Eucalyptus (*Eucalyptus spp.*)



Figure 50: Rainbow eucalyptus tree

- One of the fastest growing trees –up to 12 ft/year
- Can grow very tall –second tallest tree after the sequoia
- Rich in anti-bacterial, anti-inflammatory, minty oil

### 8.2.6 Laurel (*Laurus nobilis*)



Figure 51: Laurel plant

- The bay leaf
- Anti-inflammatory and analgesic
- Helps cure ulcers

- Synergy effect with thyme and rosemary
- Can be chewed as mouthwash

### 8.2.7 Cinnamon (*Cinnamomum verum*)



Figure 52: Cinnamon plant

- Bark is used as cinnamon
- Buds are similar to cloves and are milder
- Leaves can also be used like bay leaf
- Improves digestion

### 8.2.8 Toona (*Toona sinensis*)



Figure 53: Toona tree

- Also called beef and onion tree
- Tastes like beef and onion
- Used to flavor soups and meat substitutes
- Wood similar to mahogany

### 8.3 Dyes

- Admittedly not a critical plants to have
- Synthetic dyes could be prepared in a chemical lab
- Decorative with some possible practical use

#### 8.3.1 Indigo (*Indigofera tinctoria*)



Figure 54: Indigo plant

- Improves soil quality
- Blue dye extracted from leaves

#### 8.3.2 Madder (*Rubia tinctorum*)



Figure 55: Madder root

- Red dye in roots
- Mordants change hue

#### 8.3.3 Weld (*Reseda luteola*)



Figure 56: Weld plant

- Yellow dye from leaves
- Metallic mordants change hue

#### 8.3.4 Bloodroot (*Sanguinaria canadensis*)



Figure 57: Bloodroot flowers

- Orange-red dye in roots

8.3.5 Purple Gromwell (*Lithospermum purpurocaeruleum*)



Figure 58: Purple Gromwell flowers

- Purple dye in roots

## 9 Medicinal Plants

### 9.1 Analgesics and Injury

#### 9.1.1 Marigold (*Calendula officinalis*)



Figure 59: Marigold flowers

- Mildly analgesic, anti-inflammatory
- Used as topical ointment
- Yellow dye

#### 9.1.2 Aloe (*Aloe vera*)



Figure 60: Aloe plant with flower

- Gel is used for healing burns
- Stimulates skin regeneration
- Anti-inflammatory, antibacterial
- Outside skin acts as laxative

#### 9.1.3 Comfrey (*Symphytum officinale*)

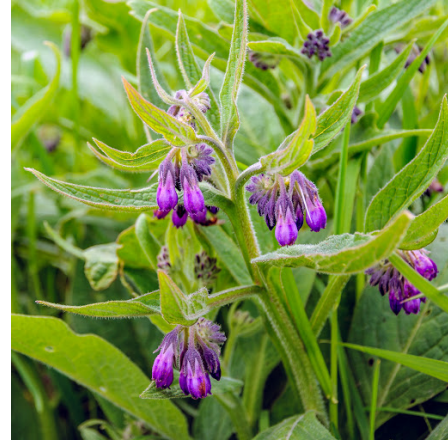


Figure 61: Comfrey flowers

- Extract has similar effect as ibuprofen
- Used topically on bruises or other injuries
- Anti-inflammatory, analgesic
- Like ibuprofen, mildly liver toxic

#### 9.1.4 Poppy (*Repave somniferum*)



Figure 62: Poppy flowers

- Source of morphine
- Opiates are used as strongest painkillers
- Highly addictive –for severe trauma only
- Ripe seeds can be used in pastry

## 9.2 Lungs

### 9.2.1 Lungwort (*Pulmonaria officinalis*)



Figure 63: Lungwort plant and flower

- Helps with lung diseases
- Cough medicine
- Sometimes added to salads

### 9.2.2 Violet (*Viola odorata*)



Figure 64: *Viola odorata* flowers

- Cough suppression
- Helps treat lung inflammation
- Anti-microbial

### 9.2.3 Ephedra (*Ephedra spp.*) and Crow-dipper (*Pinellia ternata*)



Figure 65: Ephedra (left) and crow-dipper (right) plants

- Contains ephedrine
- Used as stimulant and nasal medication
- Induces body heat generation
- Ephedrine is related to amphetamine

### 9.2.4 Licorice (*Glycyrrhiza glabra*)



Figure 66: Licorice plant and flowers

- Licorice candy is rarely made with any real licorice
- Anti-cough effects
- Improves digestion
- Corticosteroidal effect
- Overdose is potentially dangerous

### 9.3 Heart

#### 9.3.1 Ginseng (*Panax ginseng*)



Figure 67: Ginseng berries

- Boosts immune system
- Improves blood circulation
- Berries are also edible

#### 9.3.2 Aframomum (*Aframomum melegueta*)



Figure 68: Aframomum fruit

- Black pepper substitute
- Related to ginger
- Improves cardiovascular health
- Strongly anti-estrogenic

#### 9.3.3 Belladonna (*Atropa belladonna*)



Figure 69: Belladonna plant

- Source of atropine
- Used to increase low heart beat rate
- Atropine injection can stop cardiac arrest
- Relaxes eye muscles
- Antidote for organophosphate poisoning
- Highly toxic if wrongly administered

#### 9.3.4 Foxglove (*Digitalis spp.*)



Figure 70: Foxglove flowers

- Source of the drug digoxin
- Used for treating arrhythmia
- Highly toxic if wrongly administered

## 9.4 Liver and Kidney

### 9.4.1 Agrimony (*Agrimonia eupatoria*)



Figure 71: Agrimony plant

- Extract and tea is mildly analgesic
- Good for kidneys, liver, and urinary tract
- Anti-inflammatory
- Completely non-toxic

### 9.4.2 Fumaria (*Fumaria officinalis*)



Figure 72: Fumaria flowers

- Treats gall bladder problems
- Liver protective properties
- Antioxidative, anti-inflammatory

### 9.4.3 *Justicia adhatoda*



Figure 73: *Justicia adhatoda* flowers

- Liver protective properties
- Antioxidative
- Opens airways

### 9.4.4 *Phyllanthus niruri*



Figure 74: *Phyllanthus niruri* plant

- Liver protective and healing properties
- Prevents formation of kidney stones
- Decreases testosterone

## 9.5 Other

### 9.5.1 Starflower (*Sorago officinalis*)



Figure 75: Borage, also known as starflower

- Anti-inflammatory
- Oil in seeds help with arthritis and asthma
- Edible –leaves have similar taste to cucumber
- Flowers have honey taste
- Antioxidative

### 9.5.2 Black Caraway (*Nigella sativa*)

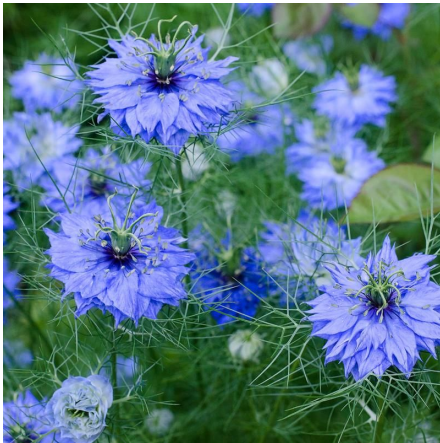


Figure 76: Black caraway flowers

- Anti-inflammatory, antioxidative
- Limits tumor growth

### 9.5.3 Saint John's Wort (*Hypericum perforatum*)



Figure 77: Saint John's Wort

- Tea acts as an antidepressant
- Stimulates liver function
- Antimicrobial, anti-inflammatory properties
- Can be used in topical ointments for cuts and bruises
- Poisonous in large doses (cattle grazing)
- Decreases estradiol level