

# Adding Value to Natural Products: Process development

Dr Stephen Tallon, Natural Health Products Suppliers Day, 21<sup>st</sup> August 2019

# An engineering take.....

- » Inputs (what is in the raw material)
- » Outputs (what kinds of products can be made out of them)
- » Processes (how to get there)



# Inputs



Carbohydrates

Proteins

Lipids

Other

Sugars

Fibre

Steroids

Enzymes

Collagen

Growth Factors

Amino Acids

Peptides

Oils / Fats

Carotenoids

Flavours

Emulsifiers

Colours

Flavours

Aroma

Antioxidants

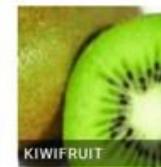
Vitamins

Minerals

That's why our **members'** products are in demand from consumers and manufacturers the world over.

Natural Health Products New Zealand – made from nature.

### FEATURED INGREDIENTS

**BEE VENOM****BLACKCURRANTS****COLOSTRUM****DEER VELVET****ENZOPENOL****FISH OIL****FLAXSEED OIL****GRAPE SEED EXTRACT****GREENLIPPED MUSSEL****HEMP SEED OIL****HOROPITO****KIWIFRUIT****MANUKA HONEY****TOTAROL**

Blackcurrants have very high vitamin C content along with potassium, phosphorus, iron, vitamin B5 and a range of other nutrients. They also have phytochemicals such as anthocyanins (or polyphenols). The major anthocyanins in blackcurrant pomace are delphinidin-3-O-glucoside, delphinidin-3-O-rutinoside, cyanidin-3-O-glucoside and cyanidin-3-O-rutinoside. Blackcurrant seed oil is rich in gamma-linolenic acid (GLA), an essential fatty acid, along with many other nutrients.



BEE VENOM



BLACKCURRANTS



COLOSTRUM



DEER VELVET



ENZOPENOL



FISH OIL



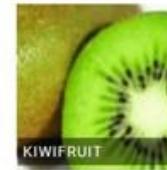
FLAXSEED OIL

GRAPE SEED  
EXTRACTGREENLIPPED  
MUSSEL

HEMP SEED OIL



HOROPITO



KIWI FRUIT



MANUKA HONEY



TOTAROL

Kiwifruit has very high levels of vitamin C and potassium. It also has a wide range of nutrients such as dietary fiber, vitamin E, folic acid, copper, pantothenic acid, calcium, magnesium, iron, vitamin B6 and phosphorus. It has low sodium, low fat and no cholesterol. Kiwifruit extract contains protease enzyme obtained from kiwifruit. The extract has high level of actinidin which mimics the enzyme pepsin in humans. It also contains antioxidants and essential fatty acids.



BEE VENOM



BLACKCURRANTS



COLOSTRUM



DEER VELVET



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FISH OIL



FLAXSEED OIL

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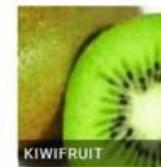


TOTAROL

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# Polarity

Insoluble

Polar

Non polar

Water

Ethanol

Oil /Hexane / CO<sub>2</sub>

Sugars

Proteins

Peptides

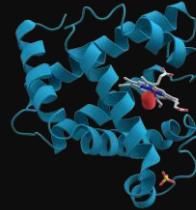
Salts

Polar lipids

Phenolics

Oils

Pigments



# (effective) molecular size

Particulate      Cellular      Macromolecules      Single atom

 $10^{-3}\text{m}$  $10^{-7}\text{m}$  $10^{-10}\text{m}$ 

Seeds

Algae

Proteins  
Enzymes

Peptides

Free fats

Salts

Sediment

Bacteria

Viruses  
PolysaccharidesGlobular fats  
Oligosaccharides  
PolyphenolicsSimple sugars  
Phenols

Polymers



# Outputs



Performance

Value

Composition

Stability

Market size and price

Product spec

Solubility

Volumes

Active constituents

Smell

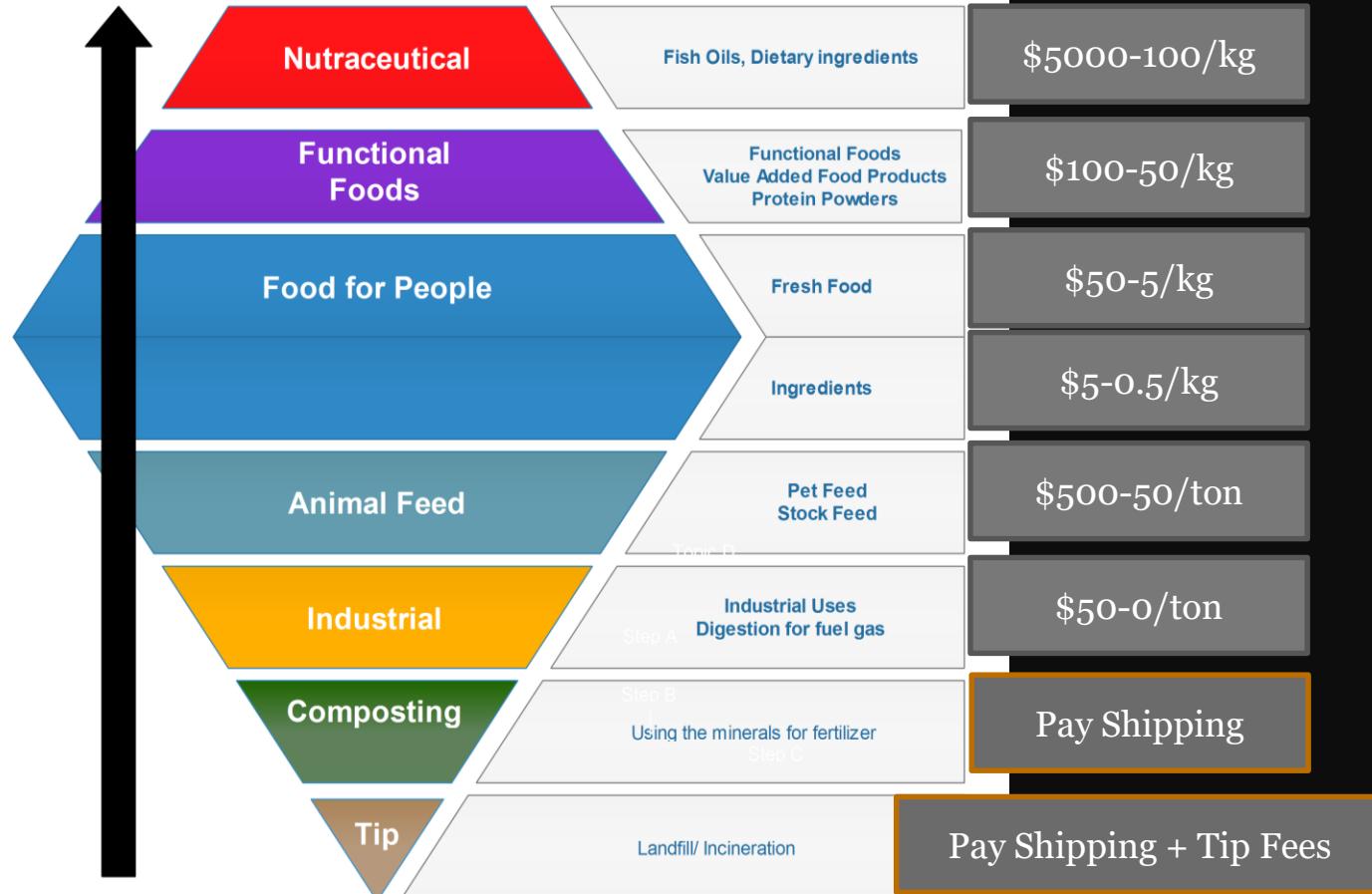
Cost to produce

Contaminant limits

Taste

Efficacy

# Food Value Chain Hierarchy



# Outputs

- » Solids / Powders
- » Liquids
- » Other
  - » Suspensions
  - » Emulsions
  - » Gels
  - » Gums
  - » Creams
  - » Pastes



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# Processing OPTIONS

## Deconstruction

- Physical (e.g. shucking, milling, dehulling)
- Chemical (e.g. enzymatic, chemical hydrolysis, cooking)

## Physical separation

- Size (filtration)
- Density (centrifugation)
- Phase change (distillation)

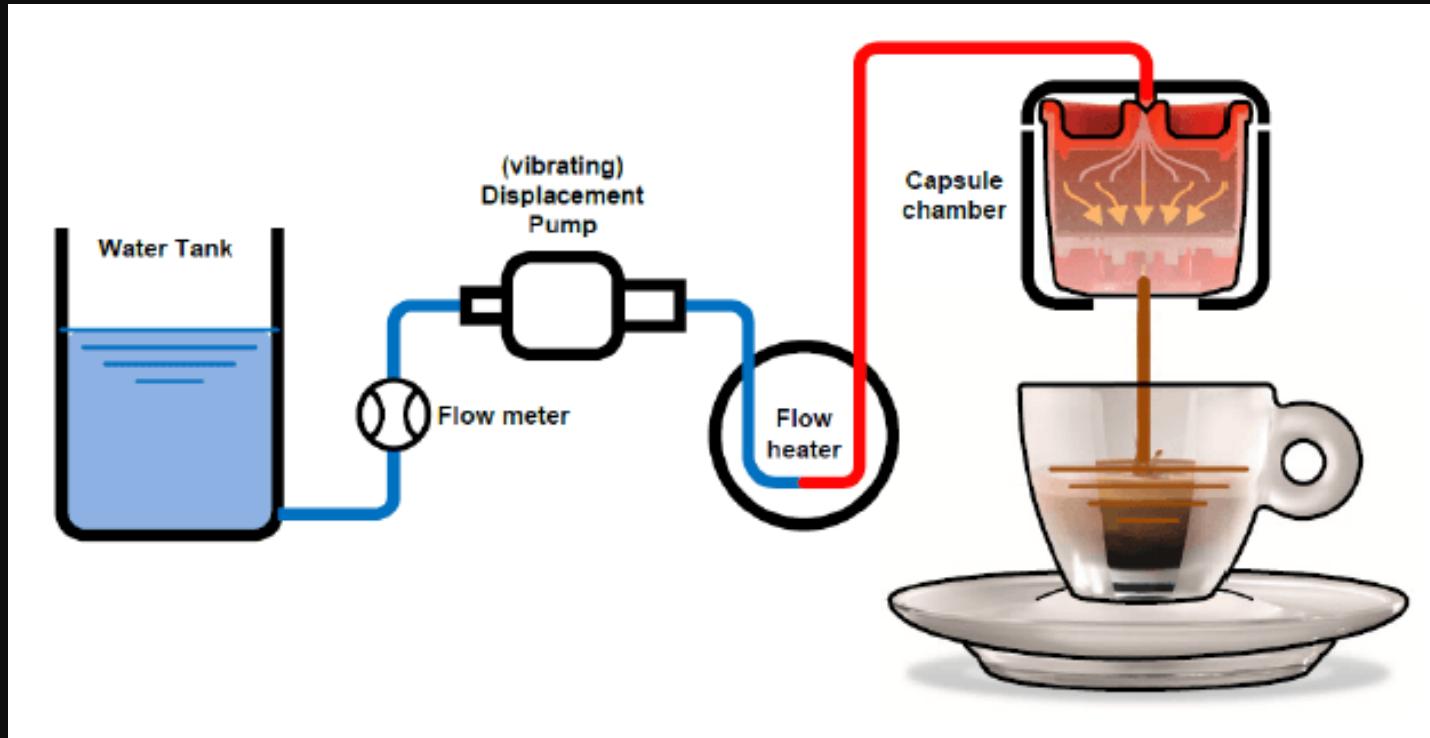
## Chemical separation

- Solvent extraction / Crystallisation
- Adsorption
- Chromatography

## Finishing

- Drying
- Formulation
- Emulsification

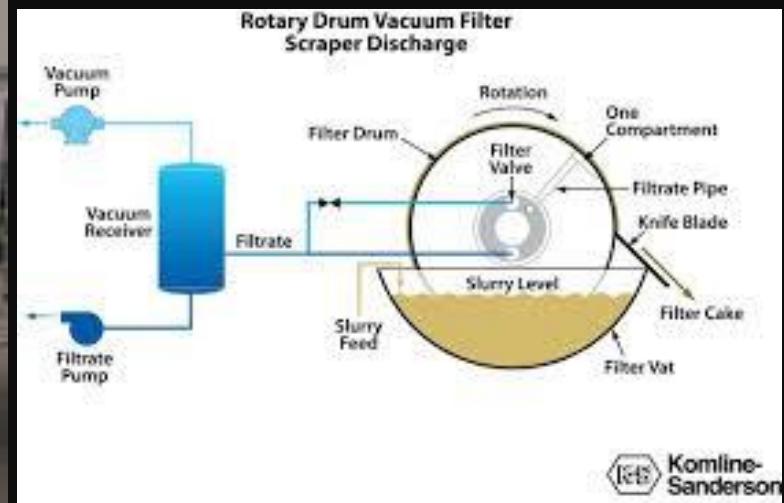
## Basic Extraction





**Tweed – Smith's Falls, Ontario,  
CANADA**  
**Canopy Growth Corp.**

# Vacuum Filter (size separation)



# Hemp Extraction Case Study



# MODERN USES FOR THE HEMP PLANT

Phytanna defines hemp as: A cannabis plant with an abundance of fiber and **less than .3% THC** (the chemical responsible for the psychoactive effects of marijuana) in the leaves/flowers

**SEEDS**

- FOODS**
  - Granola
  - Birdseed
- SEED CAKE**
  - Animal Feed
  - Protein-rich fiber

**Hempseed Oil**

- FOODS**
  - Salad Oil
  - Margarine
  - Food Supplements
  - Vitamins
  - Cooking Oils
- INDUSTRIAL PRODUCTS**
  - Oil Paints
  - Varnishes
  - Print Inks
  - Fuel
  - Putty
- PERSONAL HYGIENE**
  - Soap
  - Shampoo
  - Bath Gels
  - Cosmetics
  - Lotions
  - Balms

**LEAVES / FLOWERS**

- CBD**
  - Medicine
  - Recreation
  - Sacrament
- Abrasive Chemicals**

**Hemp - AGRICULTURAL BENEFITS**

- More fiber per acre than any other crop
- Less pesticides required for pesticides than most crops
- Whole Plant
- Pollen isolation
- Soil improvement in crop rotation
- Pyrolysis Feedstock
- Deep roots are natural soil aerators
- Boiler Fuel

**STALK / STEM**

**Bast Fibers**

**INDUSTRIAL TEXTILES**

- Twine
- Rope
- Nets
- Canvas
- Tarps
- Carpets
- Caulking
- Geotextiles
- Agro-Fiber Composites & Molded Parts
- Brake/Clutch linings

**CONSUMER TEXTILES**

- Apparel
- Diapers
- Fabrics
- Handbags
- Denim
- Shoes
- Fine Fabrics

**Hurds (Pulp)**

**Hurds (Pulp) & Bast Fibers**

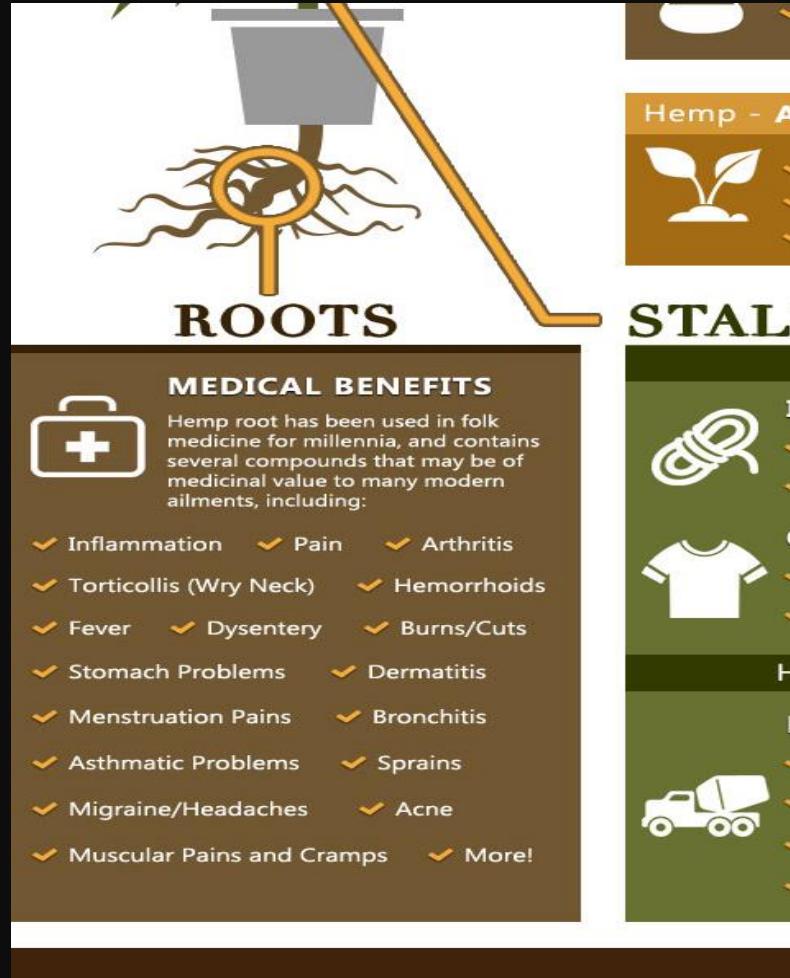
**BUILDING MATERIALS**

- Animal bedding
- Cement
- Fiberboard
- Insulation
- Fiberglass Substitute
- Mulch and Compost
- Stucco & Mortar

**PAPER**

- Printing Paper
- Newsprint
- Fine/Specialty Paper
- Cardboard/Packaging
- Filter Paper

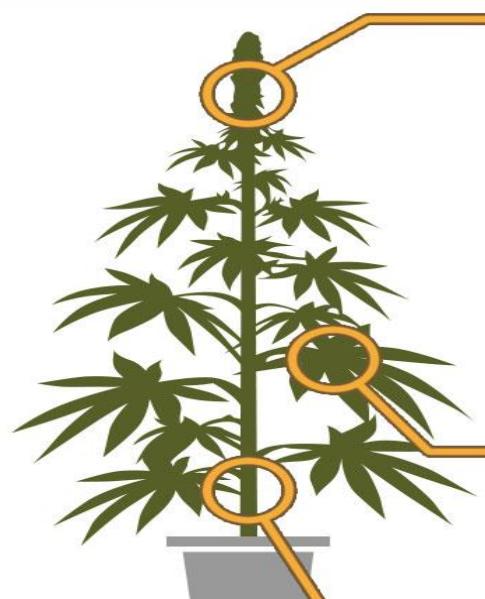
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## SEEDS



### FOODS

- ✓ Granola
- ✓ Birdseed



### SEED CAKE

- ✓ Animal Feed
- ✓ Protein-rich fiber

## Hempseed Oil



### FOODS

- ✓ Salad Oil
- ✓ Margarine
- ✓ Food Supplements
- ✓ Vitamins
- ✓ Cooking Oils



### INDUSTRIAL PRODUCTS

- ✓ Oil Paints
- ✓ Varnishes
- ✓ Print Inks
- ✓ Fuel
- ✓ Putty
- ✓ Lubricants
- ✓ Coatings



### PERSONAL HYGIENE

- ✓ Soap
- ✓ Shampoo
- ✓ Bath Gels
- ✓ Cosmetics
- ✓ Lotions
- ✓ Balms

## LEAVES / FLOWERS



### CBD

- ✓ Medicine
- ✓ Recreation
- ✓ Sacrament

### Cell Fluids

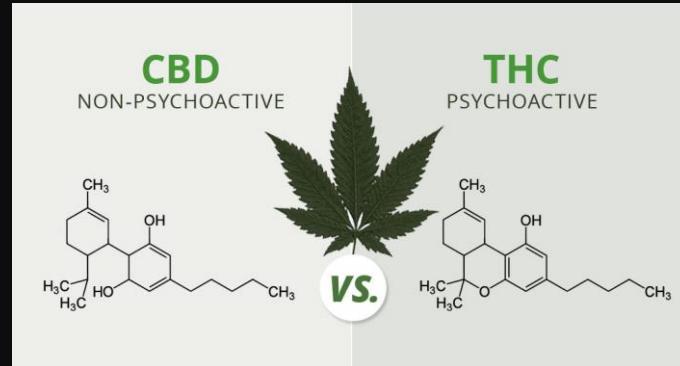


- ✓ Abrasive Chemicals



# Inputs

## Cannabinoids

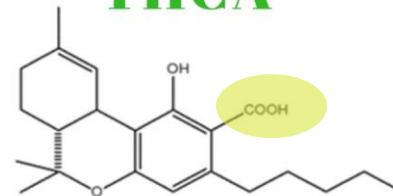


# Inputs

## Cannabinoid acids



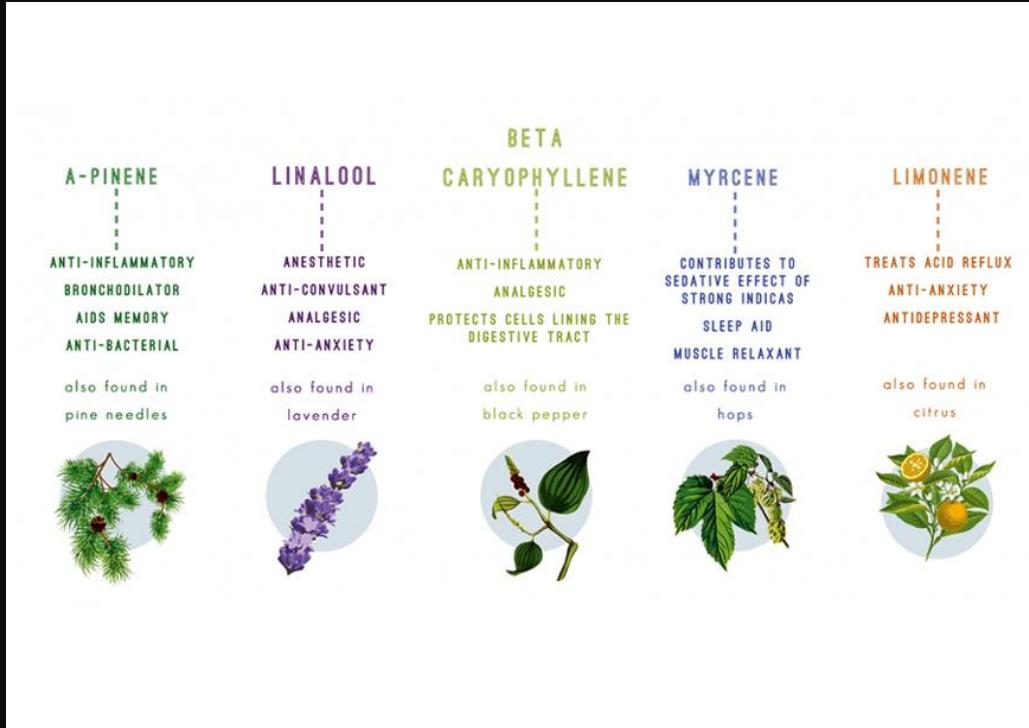
**THCA**



**Tetrahydrocannabinolic acid**

# Inputs

## Terpenes



# Inputs

Waxes, fatty acids, chlorophylls, (pesticides)



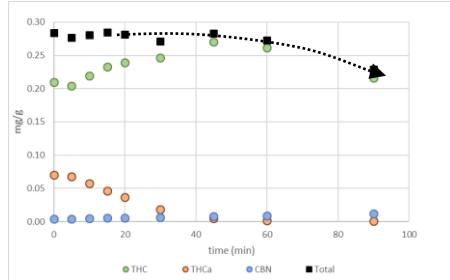
# Processing - Decarboxylation



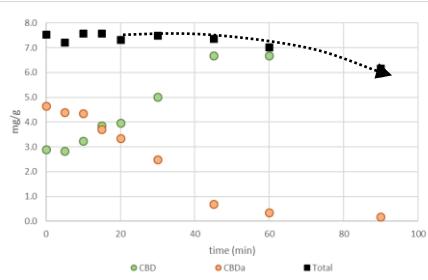
# Process - Decarboxylation

120°C

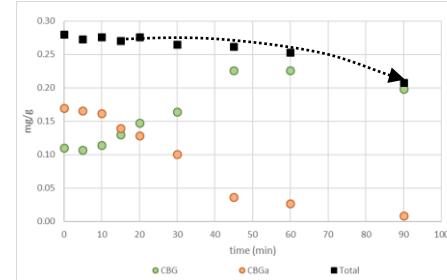
THC, THCA, CBN



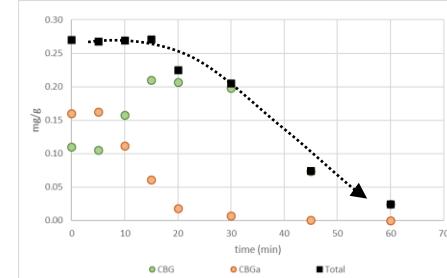
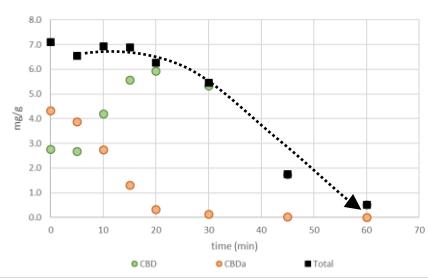
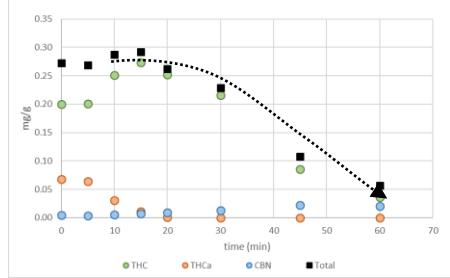
CBD, CBDA



CBG, CBGA



160°C



- ✓ Faster reaction
- ✓ Total concentration starts to decrease at longer times

- ✓ Decarb'n complete in ~20min
- ✓ Sharp decrease in total concentration after that

# Process - Extraction

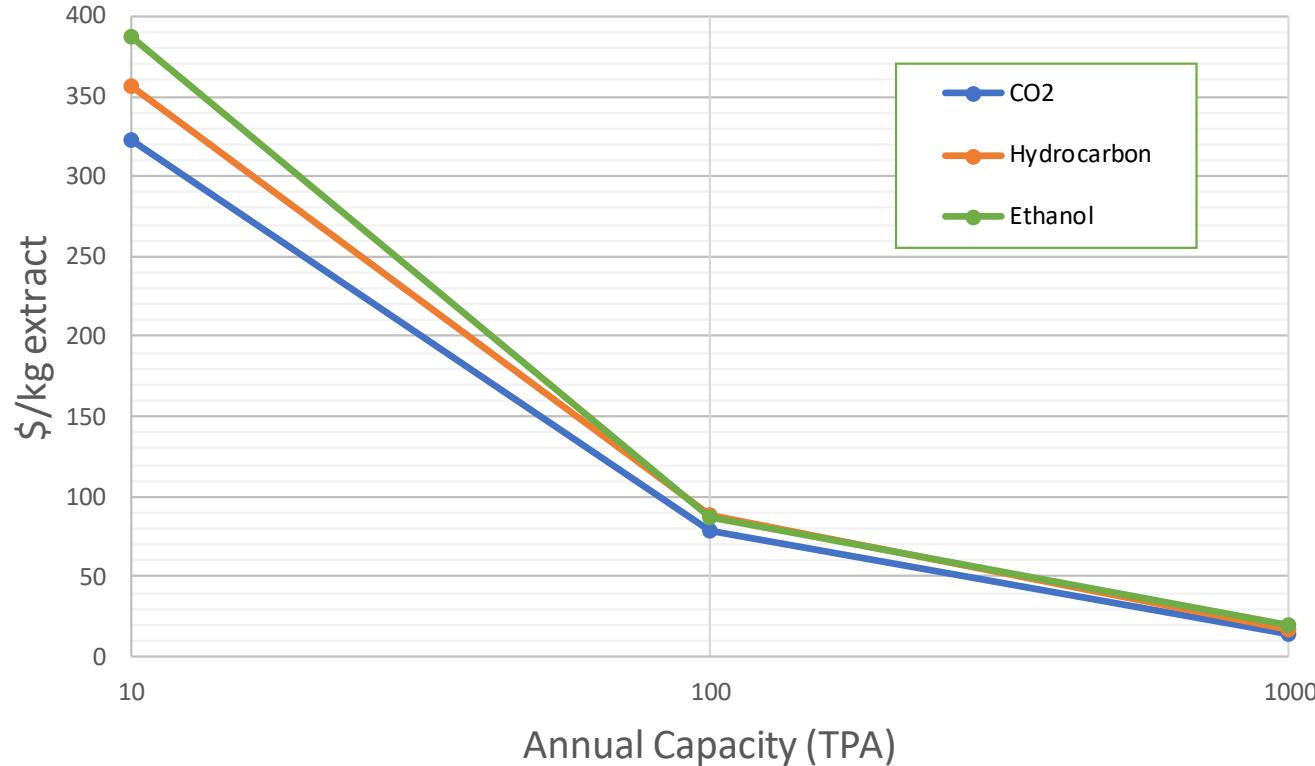


# Solvent comparison

Ethanol	CO <sub>2</sub>	Hydrocarbon
Broad range	Selective extraction	Narrow range
Flammable	Not Flammable Solvent free	Flammable
Cost: moderate	Cost: moderate	Cost: moderate



## Unit cost of processing (\$/kg extract @ 15% yield)





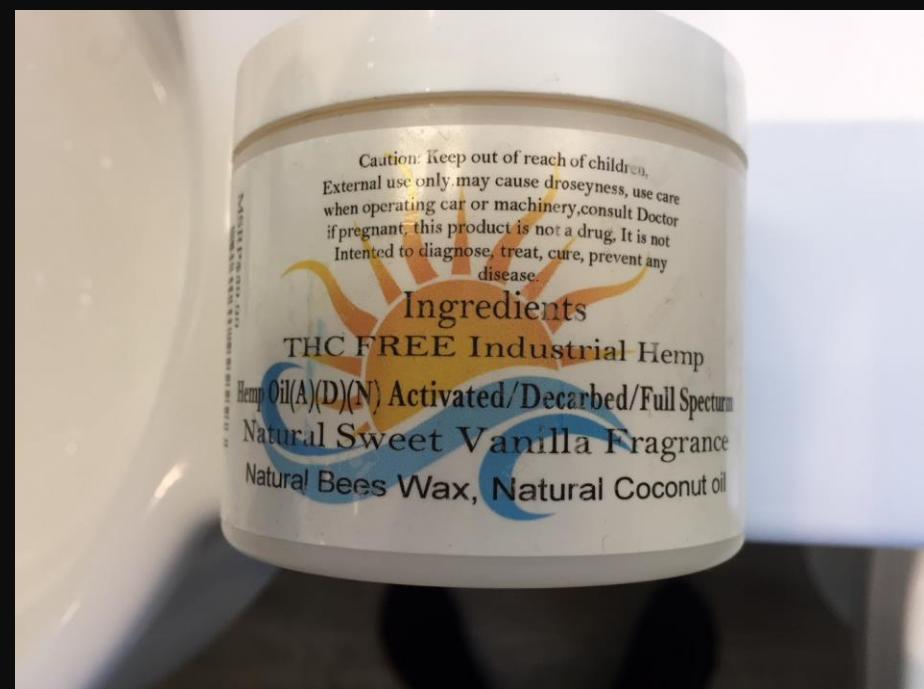




# FOOD-RELATED CANNABIS PRODUCTS



# HEMP SALVE USING DECARBED FULL SPECTRUM EXTRACT



# That's Natural! CBD-Rich Hemp Oil

**Before**



**After**



That's Natural!



Anxiety  
Stress  
Joint Pain  
& More!



# Our services for business

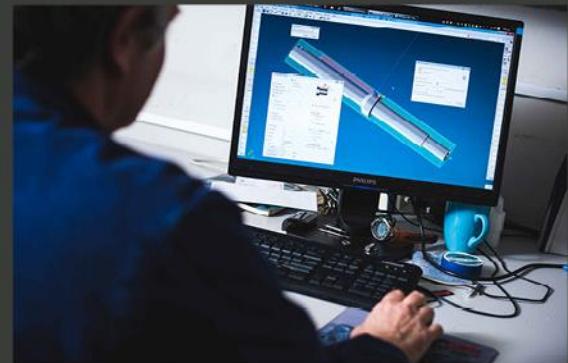
► R&D



► Innovation skills



► Grants



# Research and development (R&D)

- » Advanced materials
- » Biotechnologies
- » Advanced manufacturing
- » Internet of Things & Data Solutions



# Innovation skills programmes

- » Better by Lean
- » Build for Speed
- » Driving Innovation
- » High Performance Working Initiative
- » Rukuhia (pilot) – Building innovation culture
- » Innovation IP



# R&D Grants

- » Getting Started
- » Project Grants
- » Growth Grants
- » Student Grants:
  - » Experience
  - » Fellowship
  - » Career



*Liberating*  
**INNOVATORS**