



INTERNATIONAL CONFERENCE ON
RENEWABLE RESOURCES
& BIOREFINERIES

7th-9th June 2010
Düsseldorf - Germany



Sustoil
www.sustoil.org
9th June 2010

Title

Optimisation of primary processing (e.g. oil extraction and refinery, WP2)

Speaker

Wim Mulder

Institute

Wageningen UR

Sustoil
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Participants and key person

- Creol (P. Carre)
- UGent (C. Echim)
- Wageningen UR (W. Mulder)
- Rotawave (Garth Way)
- FERA (former CSL) (David Turley)
- Forth (K. Stamatelatou)
- DTU (Rafiqul Gani)
- INPT (Antoine Rouilly)
- Biorefinery.de GmbH (B. Kamm)

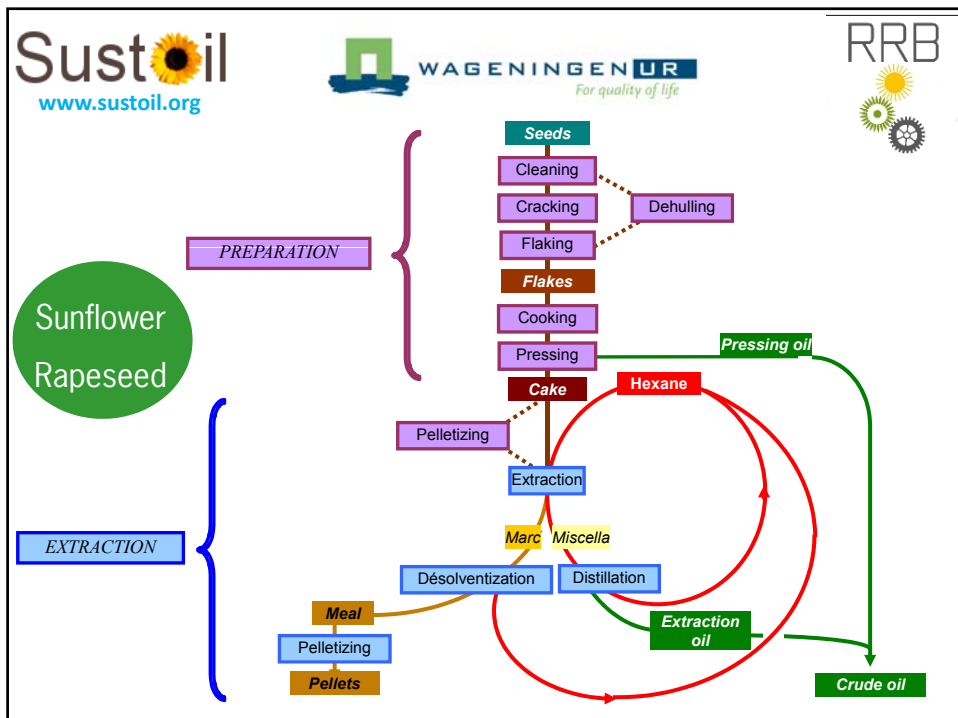
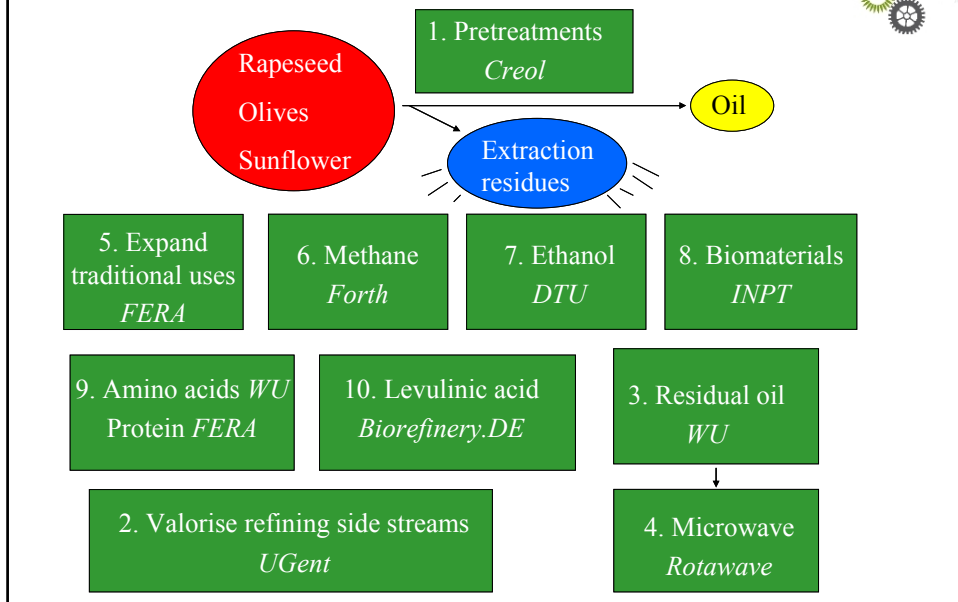
WP2; Primary processing

- Novel processing technologies
 - Technologies to extract and refine oil-rich crops
- Residual oil recovery
 - Clean technologies
- Valorisation of residues/wastes
 - Chemical products

Biorefinery oil containing seeds/fruits

How oil extraction affects the valorisation of oil seeds/fruits

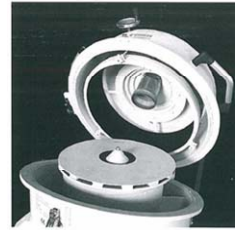
- Extraction and valorisation of the “non oil” fraction
- Lignocellulose (hulls)
- Proteins
 - 44% of defatted mass rapeseed kernels
 - 52% of defatted mass sunflower kernels
- Phenolic compounds
- Oligosaccharides
- Glucosinolates (rapeseed)



Pretreatment processes (Cetiom)

Damage oil cells, adjust oil viscosity and moisture content to facilitate oil extraction

- Dehulling
- Thermal pretreatment
- Pulsed electric field
- Enzymatic pretreatment

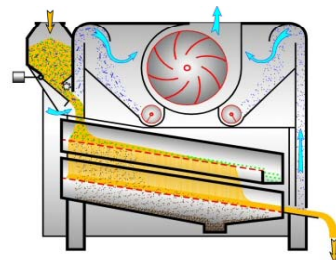


Rotor with patented guides and impact ring in the housing cover.

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Separation hulls and seeds

- Difference density between hulls and seeds
 - Aspiration of fluidised bed
 - Flow of air
 - Electrostatic charges
- Removal of non-dehulled seeds
 - Sieves
 - Specific gravity separator



Conclusions dehulling

- Rapeseed: oil losses
 - 14 kg oil/ton seeds
 - About 30% of profit
 - Valorisation hulls must compensate oil losses
 - Rapeseed hulls contain 15% protein: alfalfa substitution
 - Sunflower hulls as source for fuel
- Sunflower seed: decreased hullability
 - Inverse correlation between oil content and hullability
 - Not possible to obtain pure kernels
 - Requirements seeds with improved hullability
- Research to improve performance hull separation

- Flaking
 - Increase of surface
 - Side effect: disruption of oil bodies; enzyme hydrolysis
- Thermal pretreatment
 - Hydrothermal preconditioning improves oil availability
 - Water removal (plasticizer): reverse relation between oil yield and water content in flakes
 - 75-110°C, 8-10% moisture, 90 minutes
 - Performance of expelling correlated to heat treatment
 - However, decreased protein solubility

- Micro-wave and radio-frequency
 - Heating effect based on interaction between electromagnetic field and dielectric effects (polar molecules)
- Pulsed electric field
 - Non-thermal food processing technology
- Enzymatic pretreatment
 - Disrupture of cell walls (seeds)
 - Disrupture of cell walls and rupture of interface of lipoproteic membranes (fruits, colloidal emulsions)
 - For olives: 40% increased throughput

Microwaves (Rotawave)

Microwaves

High Penetration

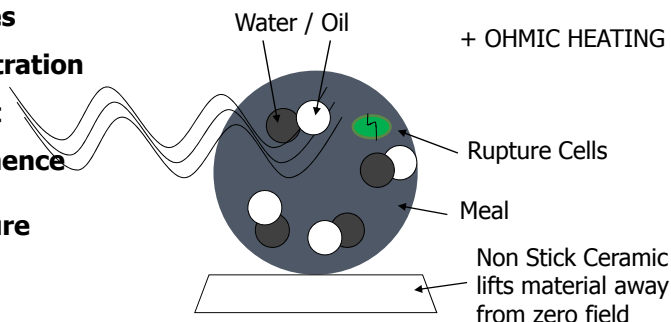
No contact

Selective hence

Low Bulk

Temperature

No fouling



Oil recovery; pressing and related processes (WUR)

■ Screw pressing

- Continuous screw presses (expellers)
- Cold pressing of rapeseed and sunflower not possible
- Single pressing: oil content of rapeseed and sunflower cake 10%
- Pre-pressing: cakes with 15-18% oil
- Residual oil removed by hexane: sunflower cakes with 2% oil and rapeseed with 3.5% oil

■ Extrusion

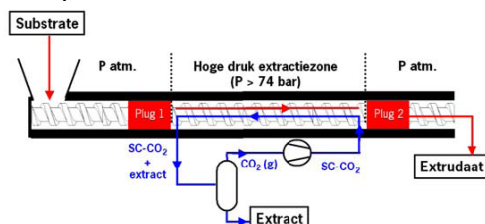
- Alternative process giving good oil quality
- 90% yield by using acidic alcohol

■ Gas assisted mechanical expressing (GAME)

- CO₂ supercritical above 31°C and 73 bar
- Dissolution of CO₂ in oil
- Pressing efficiency increases
- Main goal to develop continuous process

■ Continuous process (WUR)

- Oil extracted with CO₂



- Organic solvents (hexane, petroleum ether)
 - Solvent recovery
 - Hazardous solvents

- Supercritical fluids
 - High-value products
 - Few commercial application for commodity oils

- Aqueous extractions
 - Less effective in achieving high oil yield
 - Using enzymes improves oil extraction

Conclusions residual oil extraction

- Residual oil recovery
 - Little is know about relation between process and properties of (by)products
 - Efficiency of oil extraction process
 - Dependent of substrate (rapeseed, sunflower, olive)

- GAME
 - High oil recovery without solvent extraction
 - Mild process: recovery of other products (proteins etc)
 - Continues process needed

- Novel supercritical extrusion-extraction

- Enzymatic extraction has potential

Press cakes as a source for bioplastics (INP)

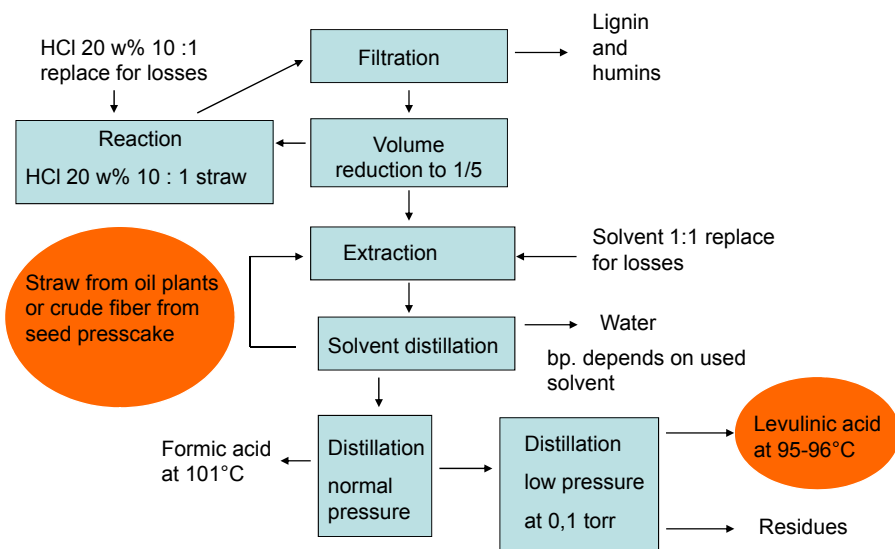
- European production of oil cakes (2005)
 - 2.7 Mt sunflower cake
 - 7.7 Mt rapeseed cake
 - 10.9 Mt soy cake
- About 150 Euro/ton for sunflower and rapeseed cake
- Thermoplastic processing
 - Film forming, extrusion, injection moulding



Conclusions biomaterials

- Products are weaker than starch based products but more water resistant en lower in costs
- Lignocellulosic material facilitates processing
- Evaluation of potential
- Possible improvements by enriching protein content in oil cakes

Levulinic acid (Biorefinery.de)

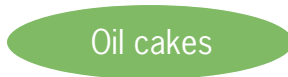
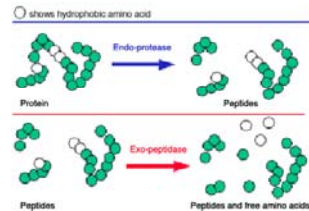


Press cake as a source for amino acids (WUR)

- Nutritional value
 - Taste
 - Physiological/chemical characteristics
- } Human food
Animal feed

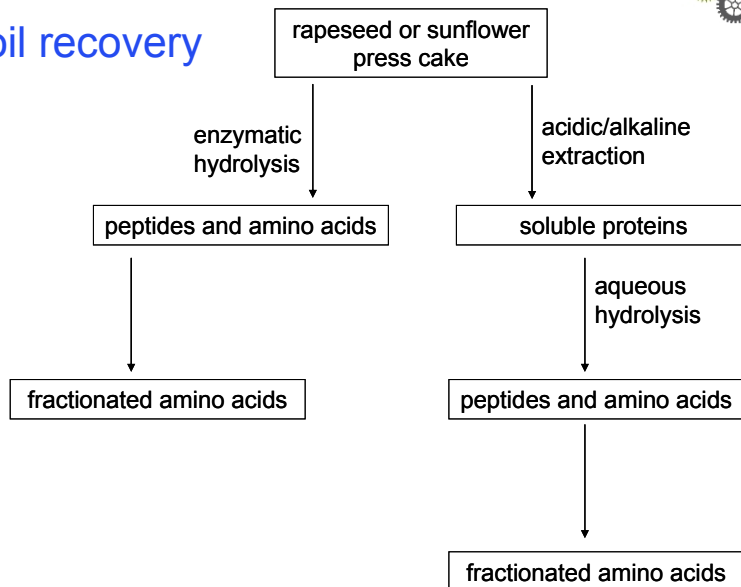
■ Production

- Chemical
- Enzymatic
- Fermentation
- Extraction

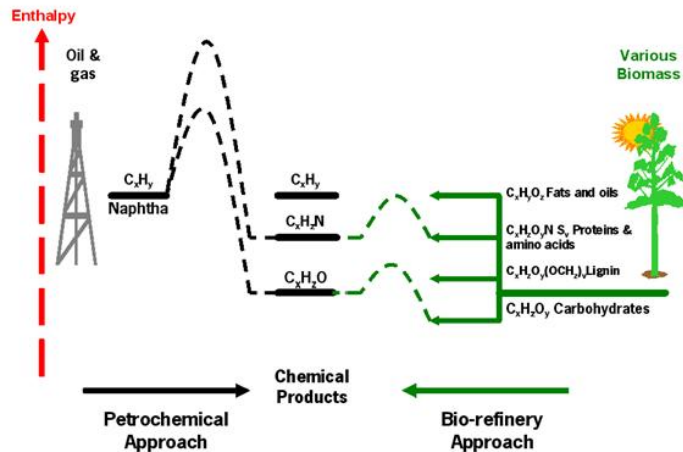


Hydrolysis

After oil recovery



Chemicals from amino acids



Conclusions proteins/amino acids

- Biorefinery on protein-rich cakes
- Extraction processes
 - Chemical
 - Enzymatic
- Use of proteins/peptides requires mild oil extraction
- Production of biobased chemicals is important
- Research necessary
 - Obtaining amino acids
 - Fractionation of amino acids

Expanding uses for meal (Fera)

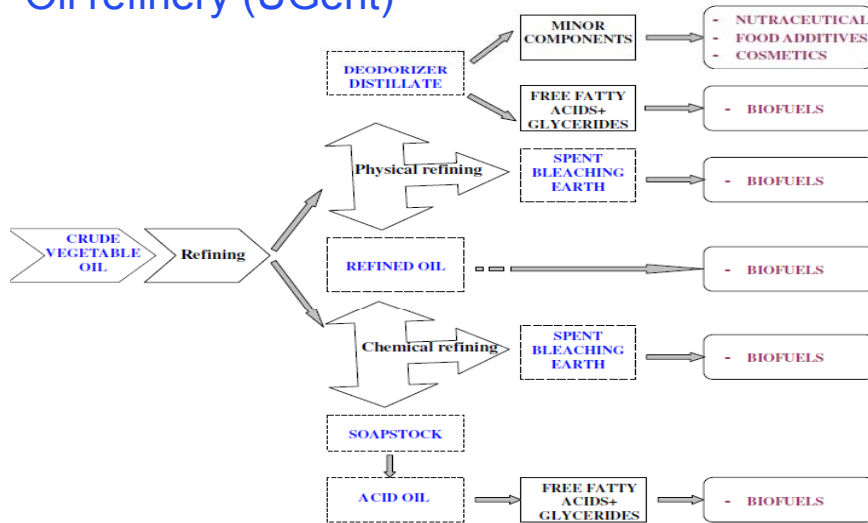
- Rapeseed meal (40% protein) limited as animal feed by:
 - Glucosinolates
 - Tannins
 - Sinapines
 - High fibre content
- 122 million tonnes of compound feed
- 27% is oilseed meal
 - 68% of this is soy meal
 - 9% of this is rapeseed meal



Alternative uses

- Proteins (concentrates and specific fractions)
- Glucosinolates
- Phenolics (sinapine)
- Biocidal proteins

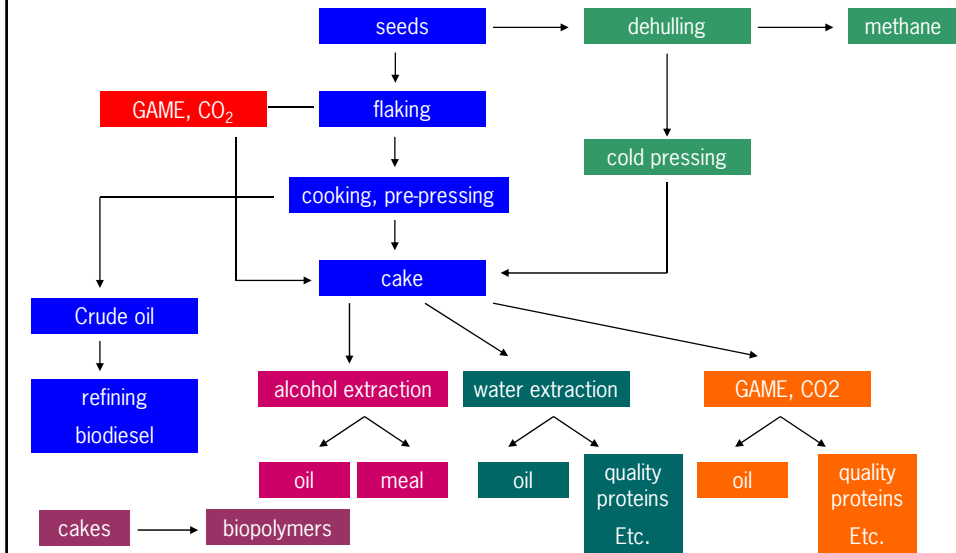
Oil refinery (UGent)



Conclusions side stream refining

- The side-streams of oil refining can be used for the biofuel production (biodiesel or Coupled Heat and Power) but require application of new technologies and/or additional purification steps.
- Most of the reported processes have scientific value and only few have found industrial application.
- Valorization of the minor components (sterols, tocopherol, squalene) from the deodorizer distillate, before or after the biodiesel production, could bring an significant revenue for the producers.

Biorefinery options



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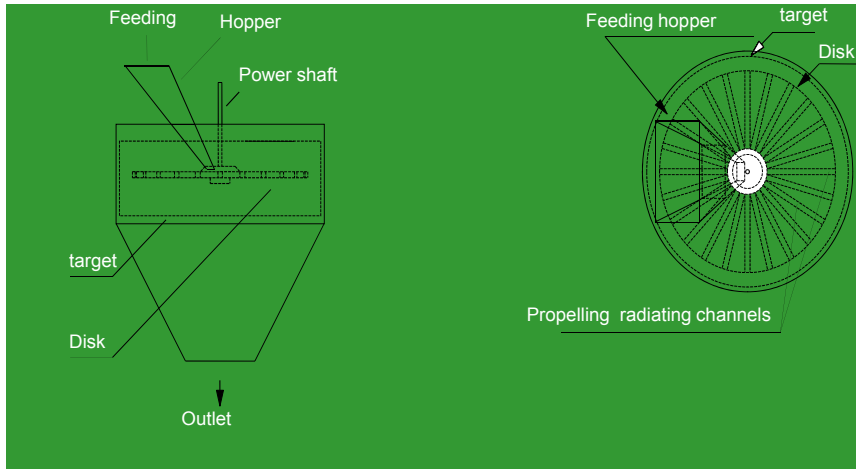


Thanks for your attention

Acknowledgements:



Rapeseed dehulling (Cetiom)

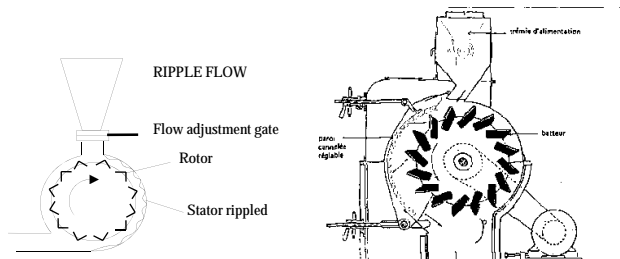


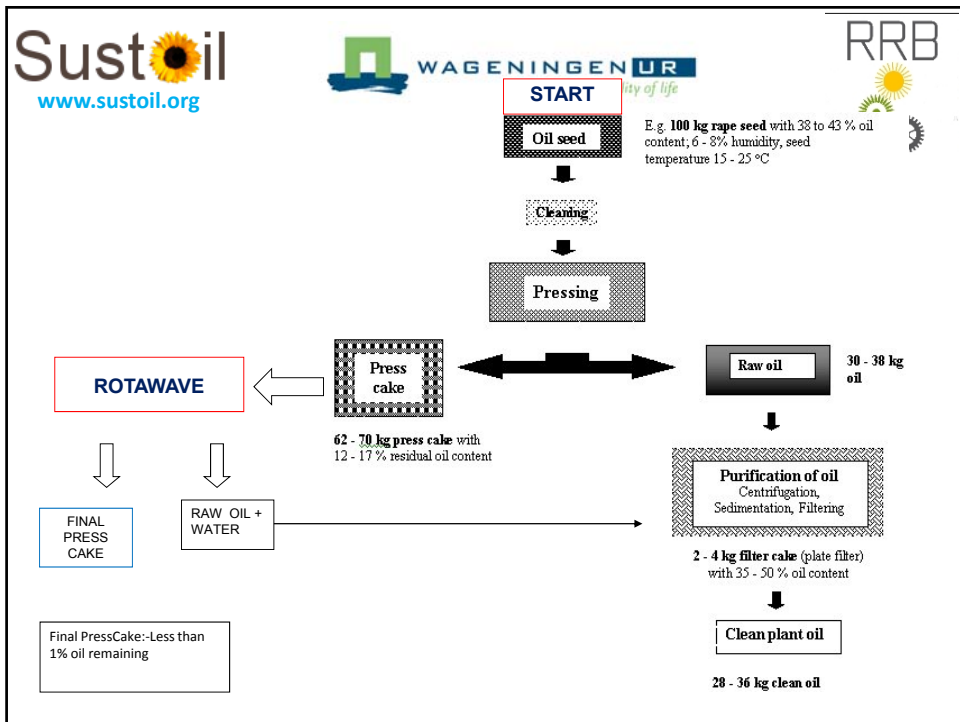
Sunflower dehulling



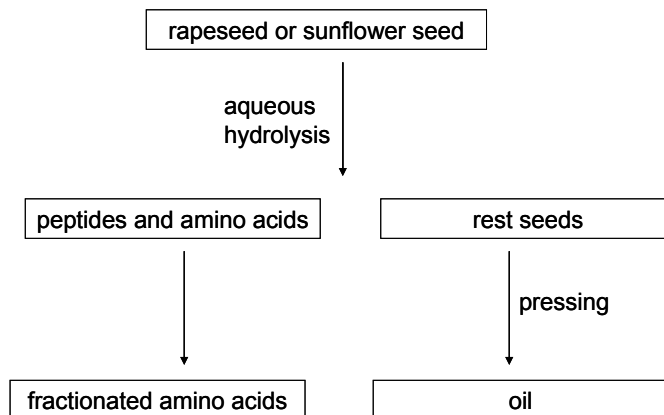
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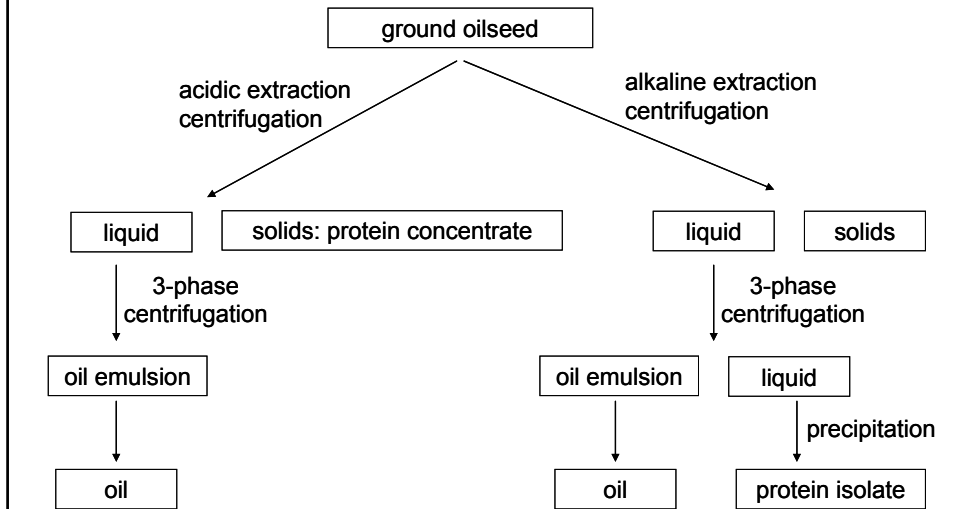




Protein extraction before oil recovery



Simultaneous oil and protein extraction



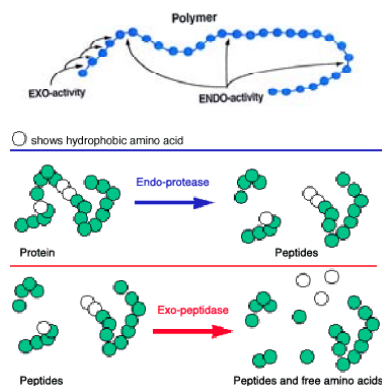
Protein hydrolysis

■ Complete hydrolysis

- 6 n HCl, 110°C, 24 hours
- 5 n NaOH, 100°C, 18 hours
- Salts incorporated
- Destruction amino acids

■ Enzymatic hydrolysis

- Peptides
- Immobilised enzymes



Valorisation of side-stream products obtained during refining of vegetable oils (UGent)

Production of biodiesel from:

- Soap stock and acid oil
- Spent bleaching earth
- Deodorizer distillate

Recovery of minor components:

- Sterols
- Tocopherol
- Squalene

