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**Title**

•Adding Value to Existing Biorefineries and Processing Facilities

**Speaker**

•Patrick CARRE

**Institute**

• ***CREOL*** (Centre d'étude et de recherche sur les oléagineux et les protéagineux)

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# Introduction

- Presentation focused on existing facilities
  - ➢Short term evolutions
  - ➢No niches markets
  - ➢Required technology available (or close)
- Order = feasibility + ➔ -

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# The oil mill industry today

- Vegetable oil and meals are commodity markets with standard quality
- Techniques are mature with no major change since WW2 (mechanical preparation + solvent extraction)
- Genetic amelioration of cultivars privileged oil content to the detriment of hullability

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- Reduction of crushing costs were obtained by increasing the size of the plants (introducing innovation is risky)
- Development of biofuel has led to investment and exceeding crushing capacity (low profits)
- Demographic development will lead to pressure on proteins resources

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# Consequences

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- ➔ Proteins use will remain focused on feed & food uses
- ➔ In the short term human use is limited by competitiveness with soy proteins.
- ➔ **Improvement of meal quality focused on fibres content and proteins digestibility are achievable and desirable.**
- ➔ Non food uses will be centred on **fibres** and other by-products

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# General scheme

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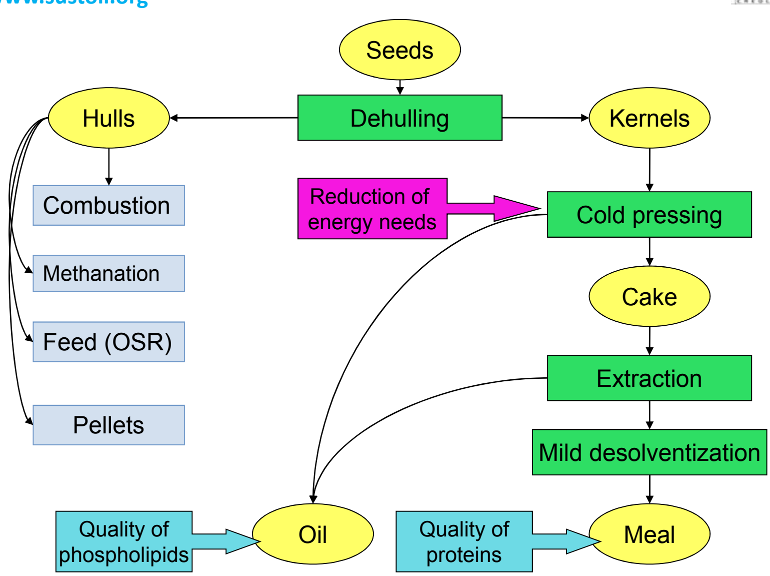

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# Dehulling
# Case of sunflower

### Composition of Sunflower achenes

| SUNFLOWER | Achenes | Pure kernels | pure hulls |
|---|---|---|---|
| % of achene DM | 100 % | 77.4% | 22.6 % |
| Oil (%/DM) | 48 | 61.25 (99%) | 2.5 (1%) |
| Proteins kjeldahl (%/DM) | 16.7 | 19.8 (92%) | 6.2 (8%) |
| Crude Fibres (%DM) | 17.3 | 2.4 (11%) | 68.1 (89%) |

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Main characteristics of sunflower dehulling

- Low oil losses in pure hull
- Limited hullablity of the moderns cultivar (50 % max)
  Smaller seeds, higher oil content, thin hulls, hull adherence
- Standard dehulled meal at 33 % of protein
- Good profitability when energy and proteins prices are high

**Current practice**

- 1 kg of SF hulls = 4.1 kWh
- Thermal energy required to crush sunflower 200-250 kWh/t
- Hulls required for the energy supply to crush 1 t : 50/70 kg
- Hull to remove to supply 35 PROFAT meal : 120 – 150 kg/t

➔ Excess of hulls available

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Possible improvements for SF dehulling

- Selection of cultivars with better hullability
- Development of pre-treatments
- New dehulling techniques

For animal feeding → 75 % dehulling (40 Profat)

For food protein → 100 % dehulling

Sale of hulls after pelletizing (90€ /t)

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# Dehulling
# Case of rapeseed

**Composition of rapeseed seeds**

| | Seeds | Kernels | Hulls |
|---|---|---|---|
| % of the seed (DM) | 100 | 86 | 14 |
| Oil (%/DM) | 47.7 | 53.3 (96%) | 12.0 (4%) |
| Proteins kjeldahl (%/DM) | 21.8 | 24.3 (96%) | 6.2 (4%) |
| Crude fibers (%/DM) | 8.1 | 2.7 (29%) | 41.2 (71%) |

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Main characteristics of OSR dehulling

- Presence of oil in the hulls
- Dehulling is difficult (small seeds, presence of kernel dust in hulls)
- Dehulled meal not available
- Poor profitability because of oil losses

**Current practice**

- No dehulling
- Impossibility to burn OSR hulls because of their oil content (formation of toxics residues

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Possible improvements for OSR dehulling

- New techniques of separation
- Recovery of the oil left in the hulls (solvent extraction)
- Methanation of hulls ?
- Marketing of hulls as feed (alfalfa substitute) ?

# Improving the value of proteins

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## Cold pressing

- Cold pressing is currently in use for organic oils but not in big industry.

➔Significant impact on energy consumption

➔Significant impact on oil quality

With dehulling and mild desolventization :

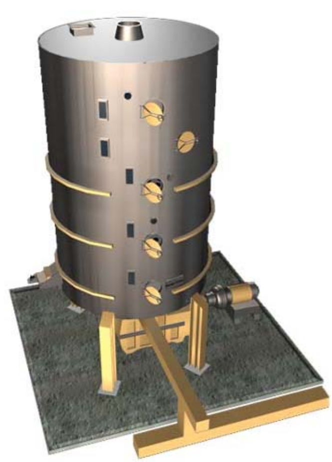
➔ Significant impact on meal quality

# Cold pressing

- Costs :
  - Reduction of press throughput
  - Press cake requires further preparation before solvent extraction
- Conclusion :
  - Feasibility requires to be confirmed
  - Profitability depend on the price of energy

# Desolventization

- Current desolventizer-toasters were optimised for low hexane losses and high capacity
- High temperature and long residence time
- Non-enzymatic browning / proteins damage



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## Mild desolventization
## **SOLUTIONS**

- Possible concepts :
  - regular DT fed with cake containing less oil
  - Pre-treatment of marc to reduce their hexane content
  - New design allowing faster heat exchange

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## Process for obtaining food grade proteins from OSR & SF

Technical obstacles :

1. 100 % dehulling of seeds
2. Cold pressing of pure kernels
3. Mild desolventization of cakes stemming form cold pressing of pure kernels.

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# Addressing dehulling issue

- Bringing the unit near to a regular processing plant where partially dehulled kernels and poorly sorted hulls are returned
- Using only special cultivars chosen for their hullability.
- Improving the dehulling technology

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# Addressing cold pressing of kernels

- Development of new screw press for that specific purpose (twin screw ?)
- Development of new conditioning able to destabilise oil bodies without loss of protein solubility

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# Addressing desolventization issue

- New design of flash-desolventizers
- Extraction carried out with supercritical solvents
- Water extraction ?

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# Replacement of hexane by alcohols

- Ethanol & isopropanol (IPA) are possible alternative solvent.
- Being polar they extract non lipidic compounds with oil
- Gucosinolate in OSR and oligosaccharides can be removed during oil extraction
- Meal could have improved feed value (higher protein content, lower anti-nutritional factors)

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# EtOH & IPA

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Facts

- EtOH requires less than 2 % of water in the cake
- Oil and alcohol are only partially miscible at high temperature
- Extraction requires more time and more solvent

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# EtOH & IPA

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- Recovery of solvent is partially feasible by winterization.
- Recovery of non lipid extracts requires nano-filtration techniques.
- Sugars could be fermented for production of ethanol.

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## GAME (Gas assisted mechanical extraction)

- Instead of being used as solvent CO2 is injected under high pressure in screw press.
- Supercritical gas help displacing the oil in the solid and allow better oil recovery.
- Harburg Freudenberger in association with Crown Iron experiment this technology in Germany
- Operational costs are not yet available

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## Simultaneous extraction and transesterification

- Flakes of oilseed are extracted by ethanol in presence of catalyst.
- Transesterification occurs during extraction resulting in ethyl-esters of fatty acids and glycerol.
- This technique is still in development. A pilot plant was implemented in La Rochelle (France).
- Results are not yet available

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# Water extraction

- Water extraction is the current technique in use for fruit oil extraction (olive, palm).
- Poor results with oilseeds
- Presence of natural surfactants (oleosins, phospholipids) ➔ formation of emulsions.
- Enzymatic treatments are proposed to reduce emulsions

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# Friolex (water extraction)

- GEA technique to avoid emulsions

  ➔ addition of alcohol to the water

Pros

- Simplicity (no enzymes)
- Inactivation of endogeneous enzymes
- Oil quality

Cons

- Cost for dying the meal (> 40 €/t)
- Operational costs not known

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# Olive oil extraction

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## Current processing

Principle:

1. Cleaning / washing
2. Crushing
3. Extraction of the juice
4. Decantation (flotation of oil)

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# Traditional method

- Stone mill used to crush the fruits
- Press

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# Traditional

- The quality of the olive oil produced is still a benchmark against which new olive oils are compared.
- The health benefit to consumers is greater (richer in antioxidants because of the absence of water. Most antioxidants are water-soluble).
- Smaller size of the mill, technology easier and cheaper
- Requires less energy than modern mills.
- Waterless system producing almost half of the liquid wastes compared to the 3-phase centrifugal system.

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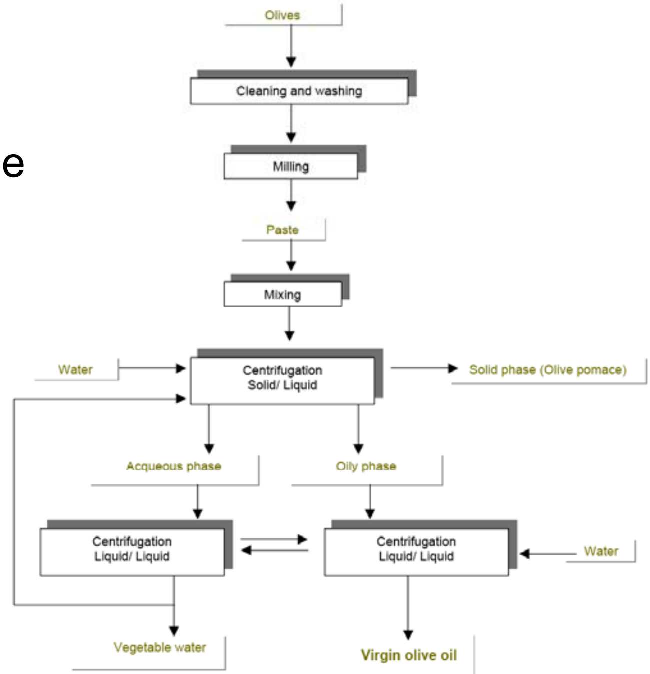
The three phases process

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# 3 phases process

- Higher processing capacity
- Better extraction yield
- Reduced labor cost
- Pollution issue (liquid wastes 1.25 to 1.75 times greater than the traditional method)

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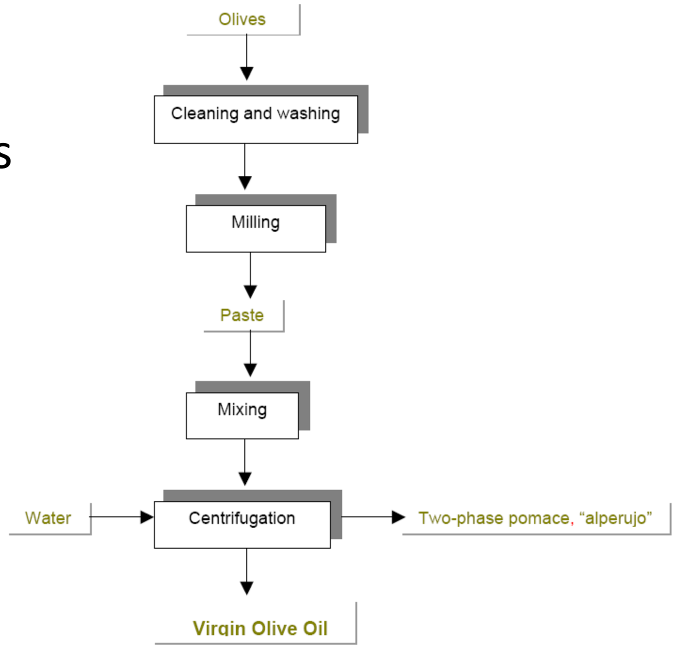
# 2 Phases process

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# 2 phases process

- Produces olive oil as the first phase
- Olive cake as the 2nd “solid” phase.
  - contains all the vegetation waters
  - doubles the amount of cake produced
  - Cake unsuitable for further solvent extraction

# Trends

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- 3 phases technology remains dominant (European cake production = 6.8 Mt/y)
- Progressive replacement of 3 phases by 2 phases because of water wastes and quality concerns

➔ Bioreffining must target the valorisation of the sludges stemming from emerging technology

# Wet pomace valorisation

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- Second decantation (repasso)
  - Low profitability
  - Low grade of recovered oil

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## Supercritical Extraction

- Temperature (28-30°C) and pressure (300 bars) required by SFE are equivalent of traditional pressing
- In comparison with hexane extraction, SFE could increase the value of pomace oil by 1.5 €/kg.
- Operation at local scale for small capacity
- Operating costs ?

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## Conclusion Oilseeds

- Proteins must remain aimed to feed and food markets
- Dehulling is a must
- Plant breeder should consider hullability
- Industry must improve protein quality (milder processes).
- Alternatives techniques are required for greener processes

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# Olive

- Main concern for wet residues from two phases process
- Methanation is likely to remain low end valorisation
- Supercritical $CO_2$: interesting but not yet available

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# Thank you