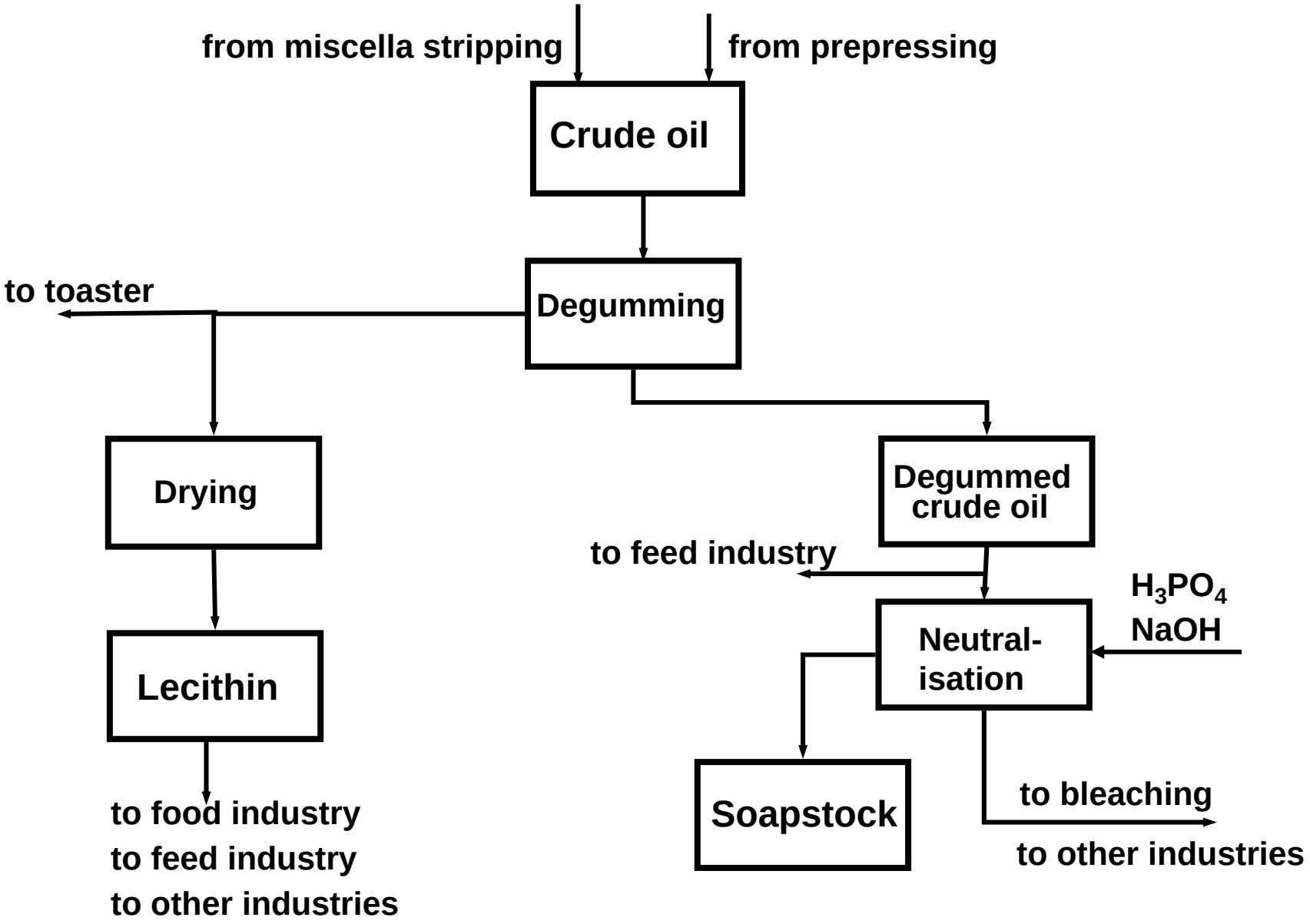
Degumming of plant oils for different applications

Dr.-Ing. Ernst W. Münch

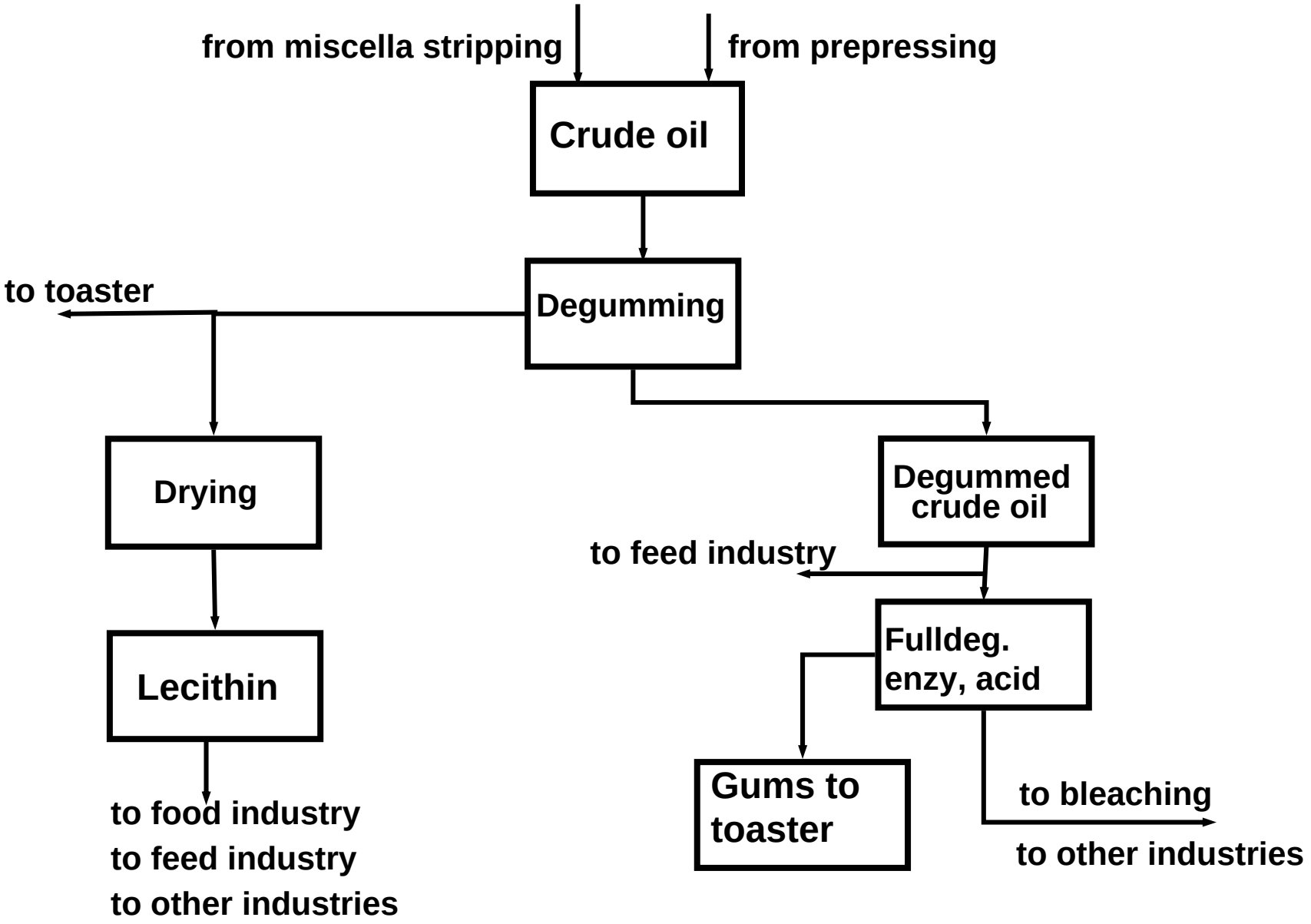
Cairo, 20th of March 2007

- Coordination of the degumming process
- Classifications of the phospholipids
- Impact of the degumming results to the conditioning process
- Degumming processes
    - water degumming
    - acid degumming
    - enzymatic degumming
- Variable costs of these processes
- Investment costs
- Evaluation of the degumming processes
- Summary

Flow Chart chemical Refining



Flow Chart physical Refining



Gums from the degumming step contain:

- **Phospholipids**
- **Carbohydrates**
- **Proteins**
- **Metals**
- **Soaps**
- **Water**
- **Small parts of free fatty acid**

Use of the gums:

- **Production of lecithin**
- **Feed to the toaster of the extaction plant**

If a bleaching process will follow or it will be used as diesel substitut the results should be:

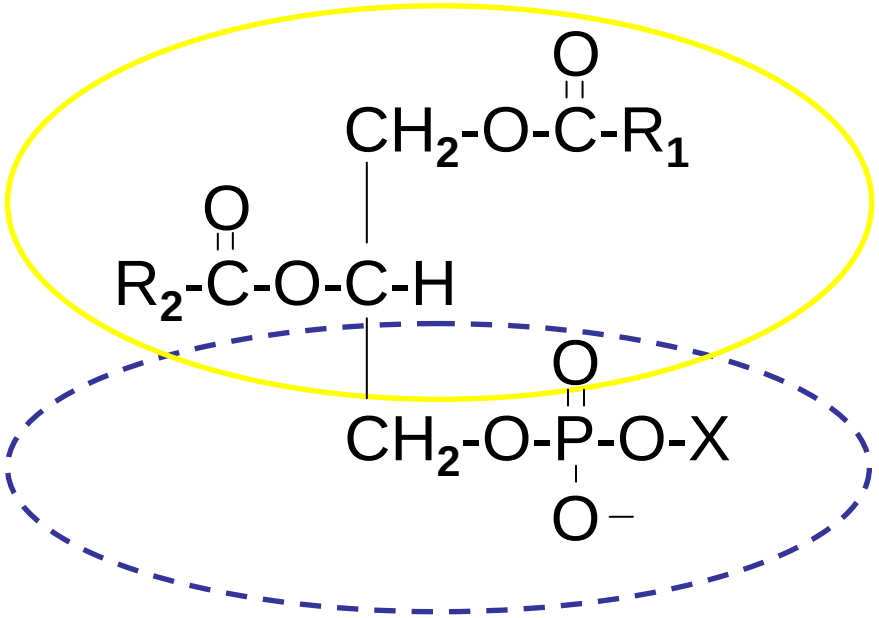
P < 10 mg/kg oil

Fe < 0.5 mg/kg oil

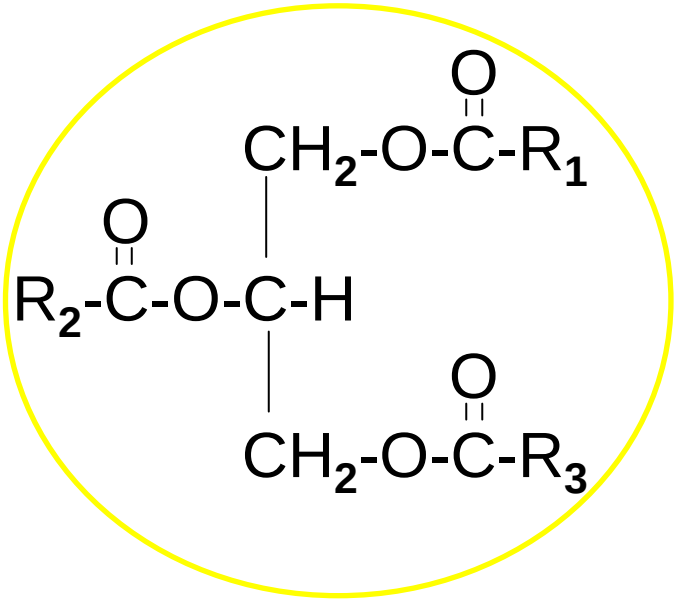
- **Phosphatidic-Choline**
- **P. -Inositol**
- **P. -Acid**
- **P. -Ethanolamine**
- **P. -Serine**

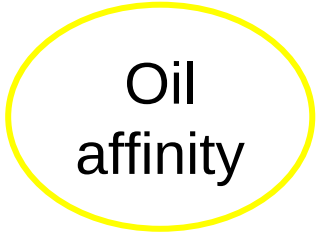
Lipids and water affinity

Phospholipid



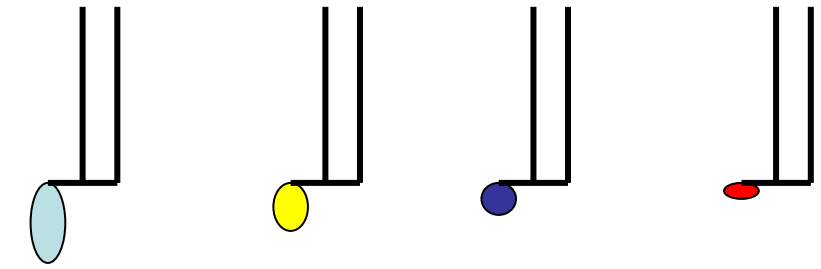
Triglyceride





$R_{\#}$ = fatty acid chains
X = H, choline, ethanolamine, serine, inositol, etc.

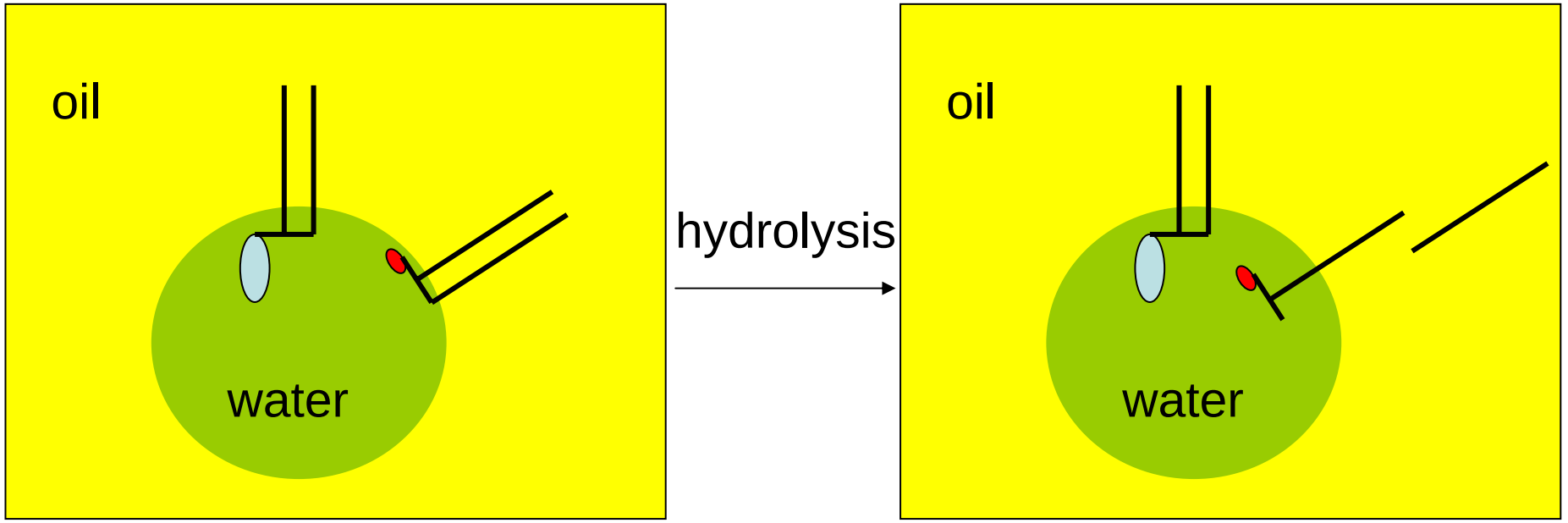
Model of the phospholipids



The groups on the phosphor differ in size and structure. The larger the group the more hydratable is the phospholipid

Lyso-forms of phospholipids are easier to hydrate

When phospholipid is hydrolyzed to lyso-form they become hydratable

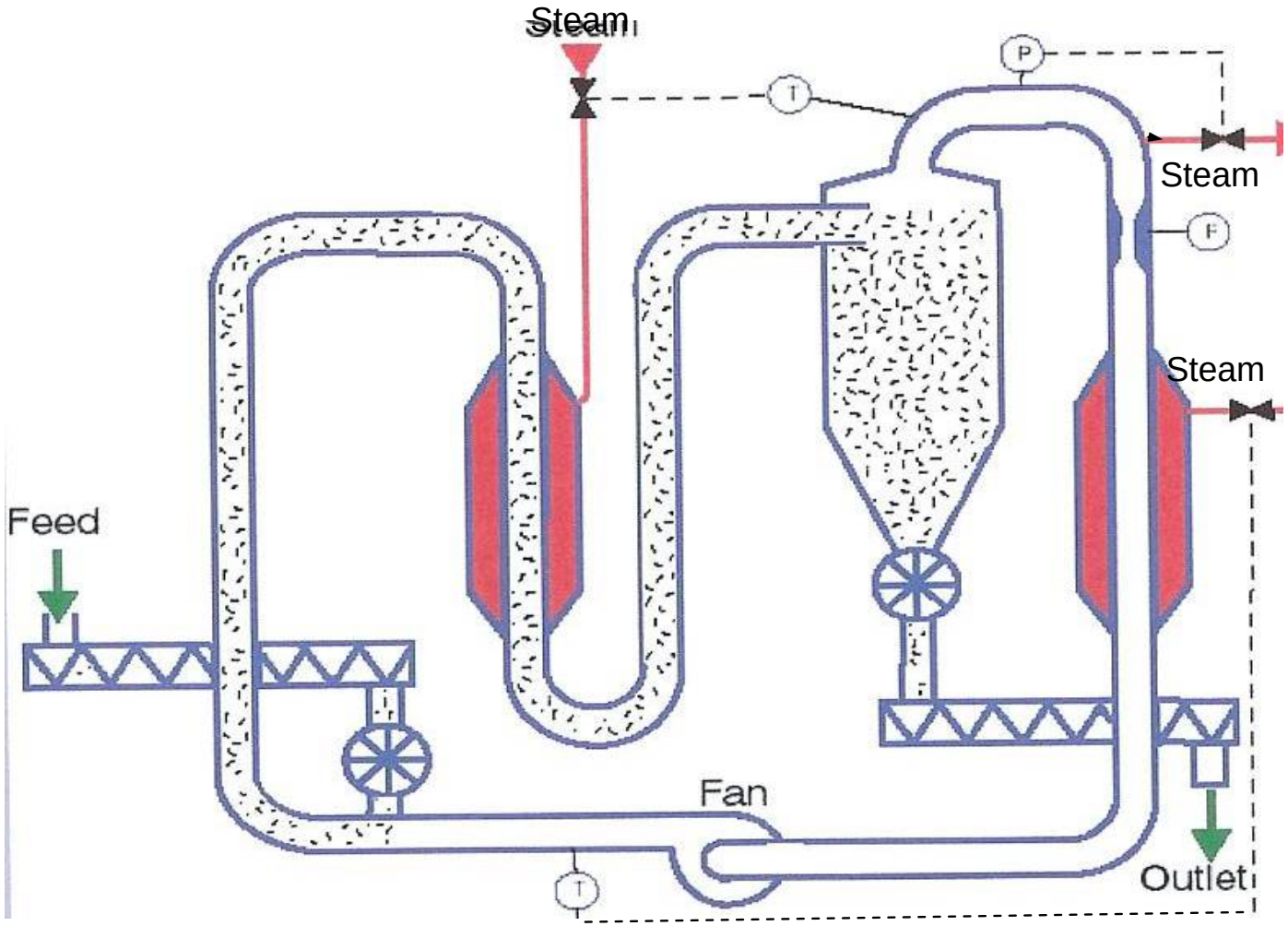


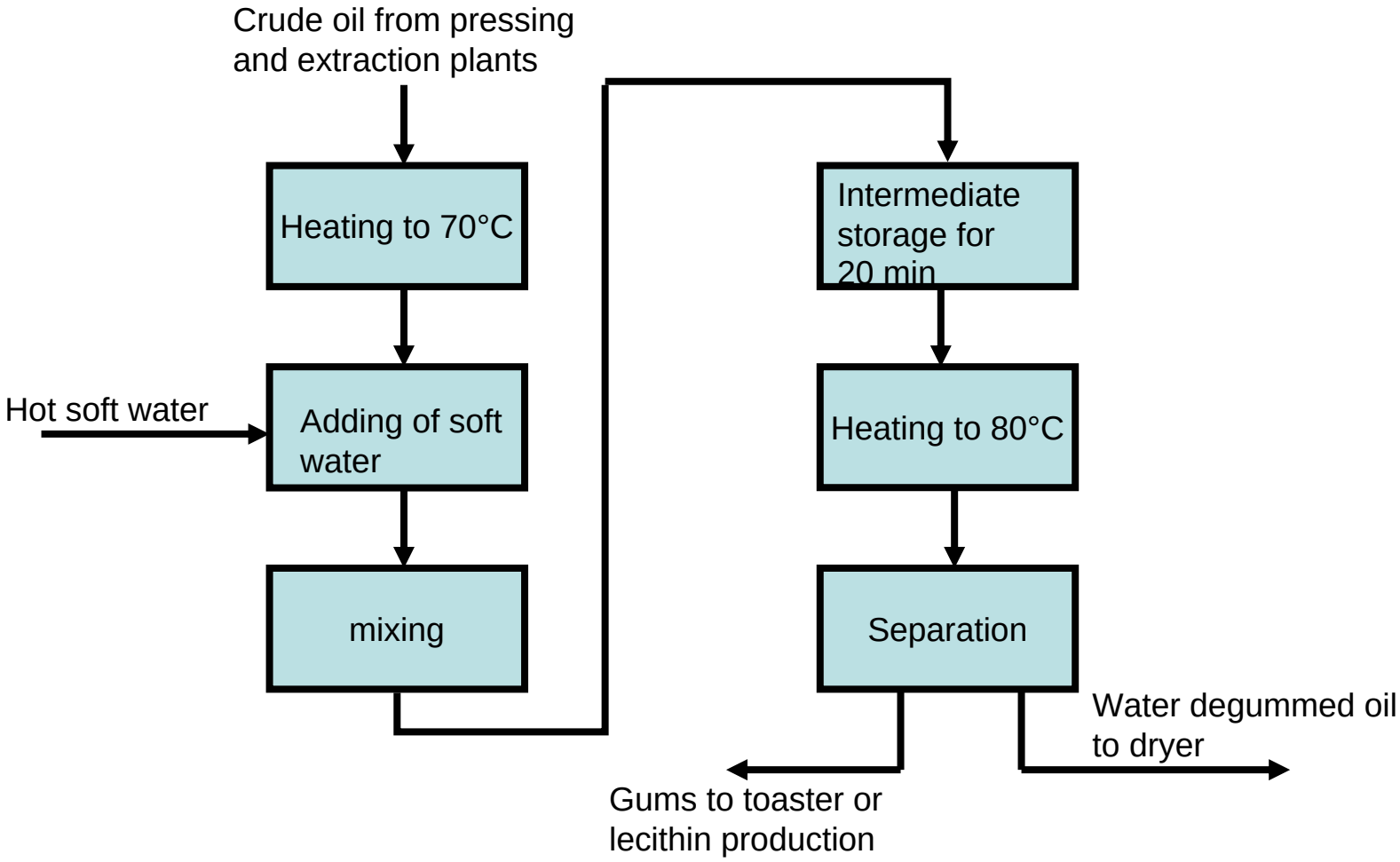
Splitting off a fatty acid makes the molecule more hydrophilic
That makes the PA easy to hydrate and remove with the water phase

Comparison of three various seed conditioning plants of the oil quality after water degumming

	plant 1	plant 2	plant 3
Rape seed ffa (%) P (mg/kg)	 0,98 31	 0,78 21	 1,02 19
Press oil ffa (%) P (mg/kg)	 0,85 50	 0,56 9	 1,16 108
Extraktion oil ffa (%) P (mg/kg)	 1,37 74	 1,17 11	 1,50 101
Total oil ffa (%) P (mg/kg)	 1,03 58	 0,78 10	 1,28 105

Conditioning of the Seed by HTST-Treatment

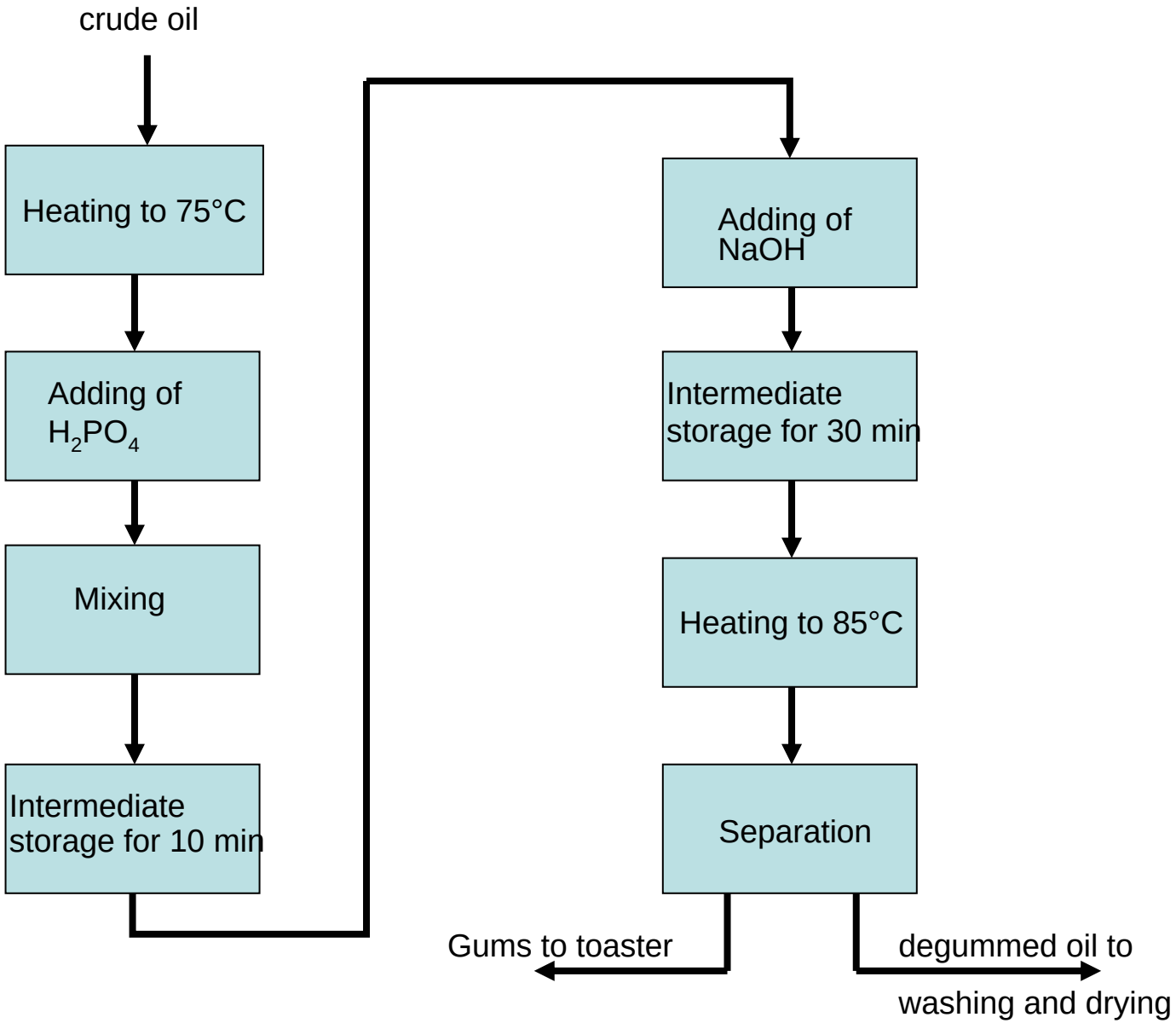




Water degumming process

P-content after water degumming

seed	process	P-content mg/kg oil
Soya beans	conventional extraction	< 200
	extraction with exergy process	< 12
Rape seed	conventional prepressing and extraction	< 250
	conditioning with exergy process	< 12
	finish pressing oil	< 150
	cold pressing oil	< 20



Acid degumming process

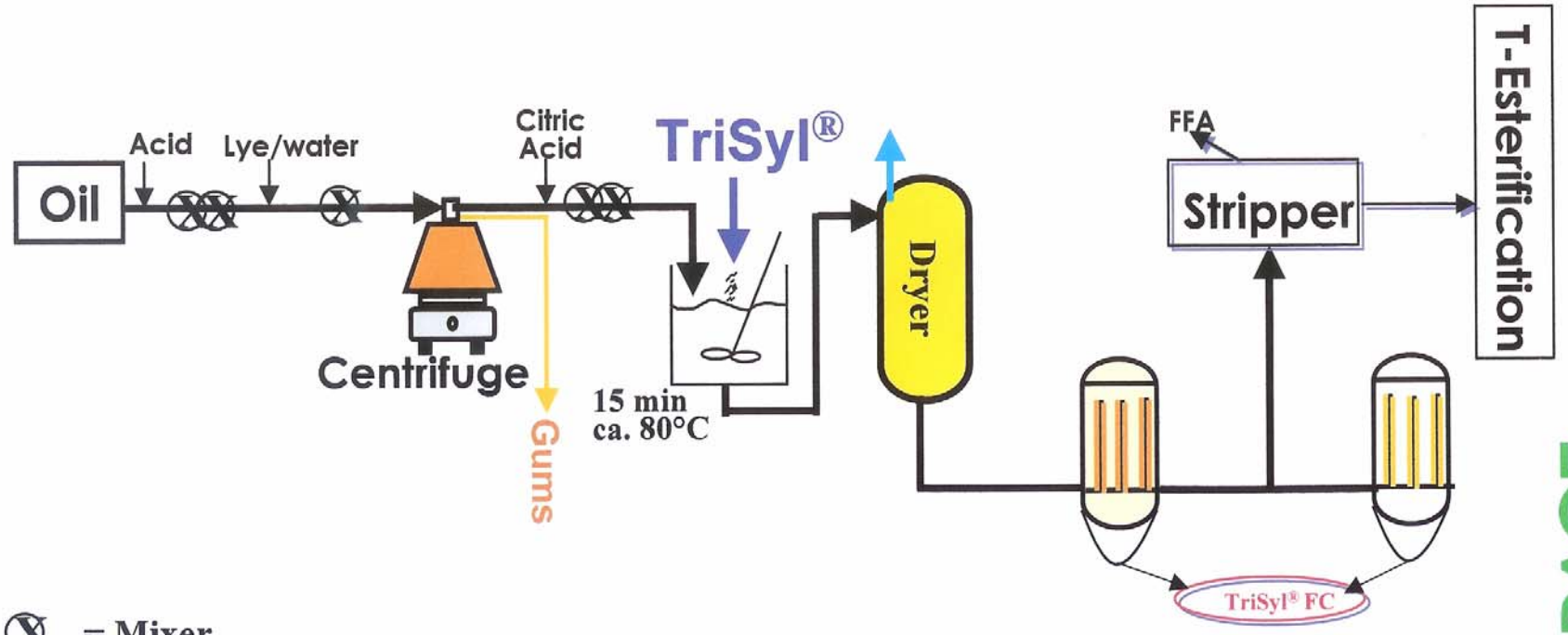
P-content of acid degumming process

seed	P – content in mg/kg oil	
	without washing	with washing
Soya beans	< 50	< 20
Rape seed	< 40	< 15
Sunflower	< 40	< 15

TriSyl® - Biodiesel Fuel Precursor Production

Physical Refining

- Filters should be first pre-coated with Clay or filter aid using clean oil

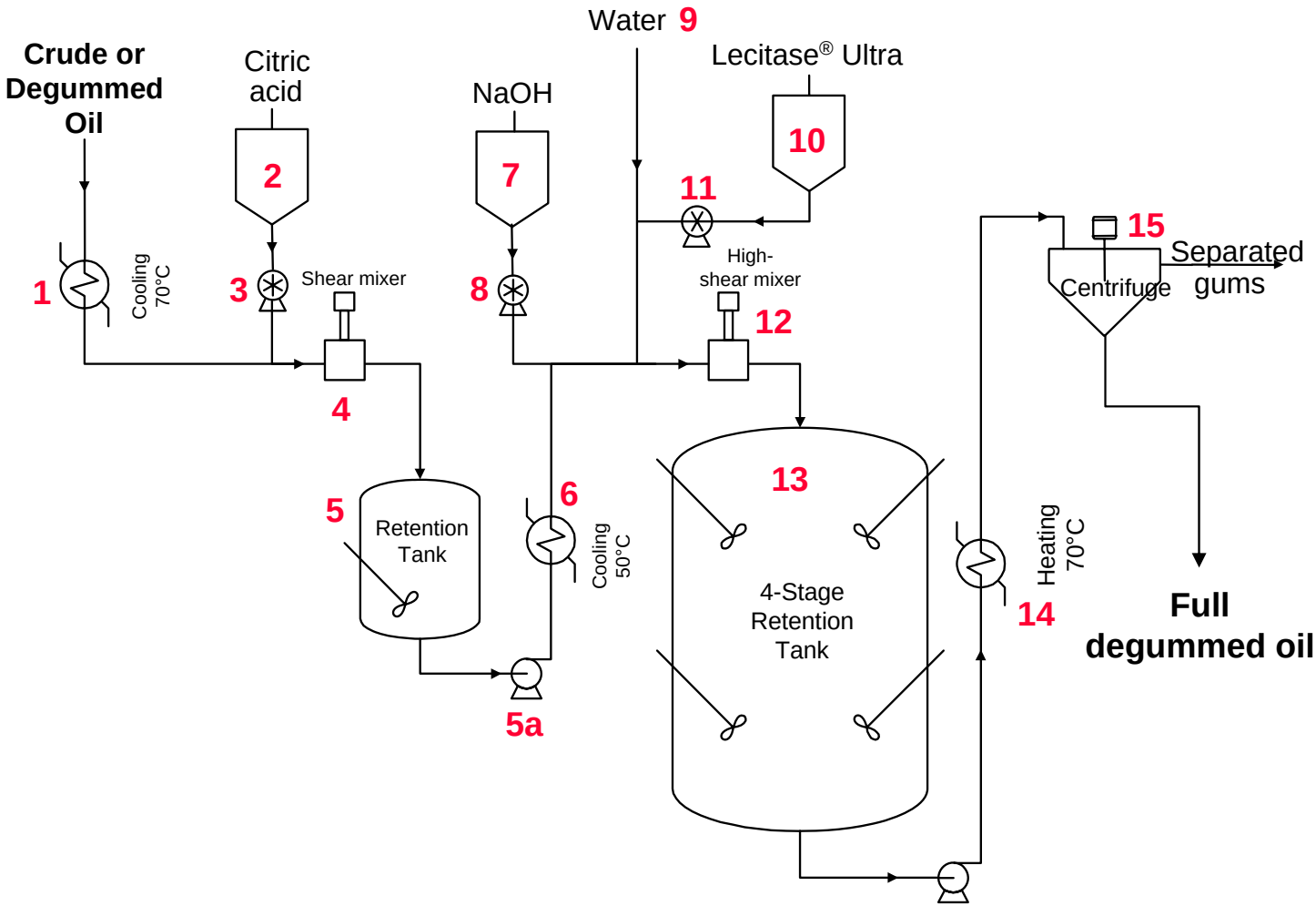


⊗ = Mixer

⊗⊗ = Homogeniser (high share mixer)

GRACE

Degumming process of Soya and Rape with the Enzyme



Equipment List for Enzymatic Refining

for a capacity of 450 t/d

Number	Process Equipment	Size, etc.
1	Heat exchanger	
2	Citric acid Storage	500 – 1000 l
3	Citric acid Dosing Pump	20 l/h
4	Shear mixer	
5	Retention tank	12 m^3
5a	Centrifugation pump	25 m^3/h
6	Heat exchanger	
7	Caustic Tank	1.5 m^3
8	Caustic Dosing Pump	60 l/h
9	Water addition	500 – 1000 l/h
10	Enzyme tank	20 l
11	Enzyme Dosing Pump	13 ml/min
12	High shear mixer	
13	Retention Tank	100 m^3
13a	Oil Dosing Pump	25 m^3/h
14	Heat exchanger	
15	Separator	

P – content of enzymatic degumming process

seed	P - content in mg/kg oil
soya oil	< 10
rape oil	< 10
sunflower oil	< 10

Variable costs and yields with the water degumming process

1. Water degumming process

steam	40 kg	€ 1.20
electricity	3 KWh	€ 0.21
cooling water	0.2 m3	€ 0.02
soft water	0.02 m3	€ 0.03
Total		**€ 1.46**

Yields: **98.0%** for soya **98.9%** for rape
2.0% **1.1%**
gums in meal or for lecithin production

Variable costs

2. **Acid degumming**

steam	60 kg	€ 1.80
electricity	5 KWh	€ 0.35
cooling water	0.2 m3	€ 0.02
soft water	0.03 m3	€ 0.05
waste water	0.05 m3	€ 0.15
lye (NaOH)	5 kg	€ 1.56
phosphoric acid	3 kg	€ 2.04
Total		**€ 5.97**

Variable costs

3. **Enzymatic degumming**

steam	60 kg	€ 1.80
electricity	5 KWh	€ 0.35
cooling water	0.2 m3	€ 0.02
soft water	0.01 m3	€ 0.01
waste water	0.04 m3	€ 0.12
lye (NaOH)	0.7 kg	€ 0.22
citric acid	0.7 kg	€ 1.89
enzyme	50 g	€ 1.75
Total		**€ 6.16**

Yields:

	acid	enzymatic
Soya	**98.8%**	**99.1%**
Rape	**98.5%**	**98.8%**
	for both degumming steps	
Soya	**96.8%**	**97.1%**
Rape	**97.4%**	**97.7%**
Lecithin or gums to meal and gums from 2nd step		
Soya	**2.0% and 1.5%**	**2.0% and 1.1%**
Rape	**1.1% and 1.8%**	**1.1% and 1.4%**

Comparison of the costs and yields of the degumming processes

Process	variable costs	rape yields	soya yields
Water degumming	1.46 €	98.9 %	98.0 %
Acid degumming	5.97 €	97.4 %	96.8 %
Enzymatic degumming	6.16 €	97.7 %	97.1 %

Total degumming costs from variable costs and yields

0.1 % of oil losses = 0.60 €

Degumming process	Soya	Rape
Water degumming	13.46 €	8.06 €
Acid degumming	25.17 €	21.57 €
Enzymatic degumming	24.56 €	19.96 €

Investment costs for a plant of a capacity of 800 t/d of oil

Costs per ton of oil by 3 years depreciation

Water degumming	680.000 € + 5.500.000 € 7.36 €/t
Acid degumming with washing	1.260.000 € 1.50 €/t
Enzymatic degumming	1.400.000 € 1.67 €/t

Degumming processes and use of the oil

Use of the degummed oil	Degumming process		
	water deg. with Exergy	acid deg. with wash.	enzymatic deg.
Vegatable oil and foot Application	++	o	++
Biodiesel	++	+	++
Fuel	++	o	++

++ excellent
+ satisfying
o sufficient

Conclusion

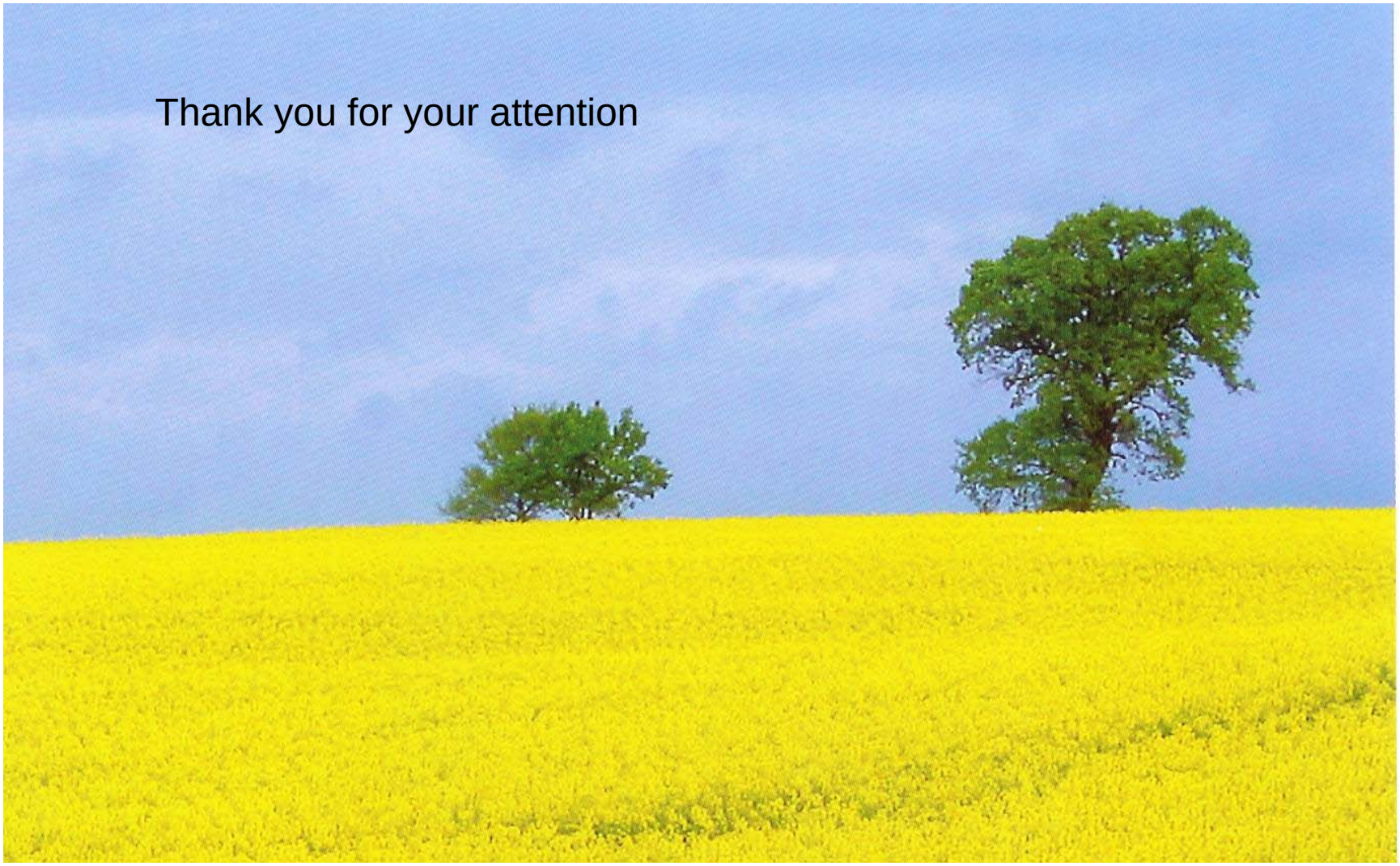
-Plant oils have a lot of undesirable components

-Part of these components can be removed by degumming processes

-Exergy process and water degumming, acid degumming and enzymatic degumming were discussed and evaluated

-variable costs and investment costs of the various degumming processes were benchmarked

-further use of the oil is essential for the choice of the degumming process


Thank you for your attention