Biofuels Activities of IFC, Uni Graz
Department of Renewable Resources

- Development of biodiesel process technologies
- Alternative feedstocks for biodiesel production
- Alternative uses for biodiesel and side products
- Research on analysis and characterization of fats and oil derivatives
- Development of specifications
- Training and seminars on biodiesel analysis and quality management
- Research on second generation biofuels: BTL, biomethanol, …

First Laboratory Experiments 1981

IFC: Over 25 Years Experience in Biodiesel

1987: 1st pilot plant worldwide for Biodiesel: Silberberg, Styria, Austria

1st Biodiesel Plant in a European Capital, BDV Vienna, 2006

Feedstocks for Biodiesel Production

First Generation:

Vegetable food oils: rape seed, palm, soybean, sunflower

Second Generation:

„New“ seed oils

Cuphea, camelina, crambe, cotton seed, GMO

Non-edible seed oils

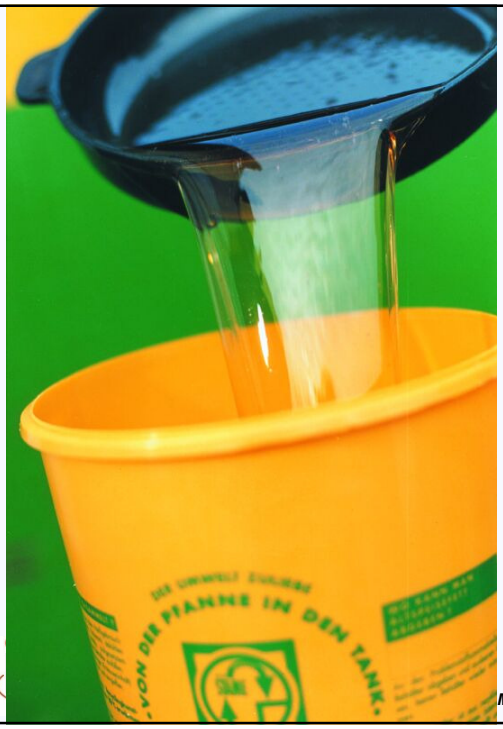
Jatropha curcas, castor oil, karanja….

Waste oils and fats

Used frying oil, tallow, soap stock, trap grease

Third Generation:

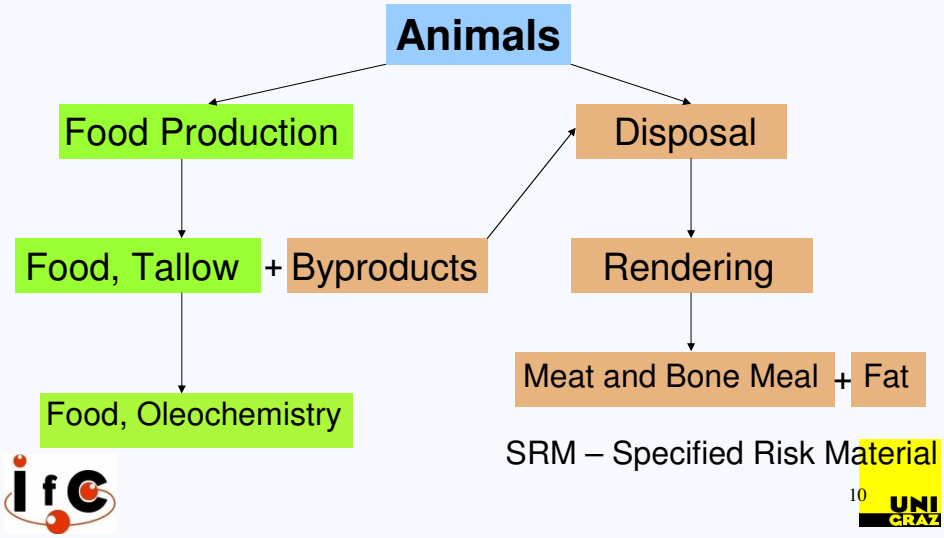
Single cell oils: algae



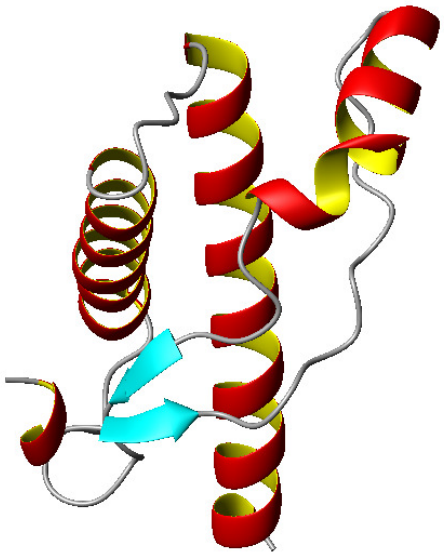
1983:

First Experiments With Used Frying Oil

Animal Byproducts as Feedstock



SRM – Specified Risk Material



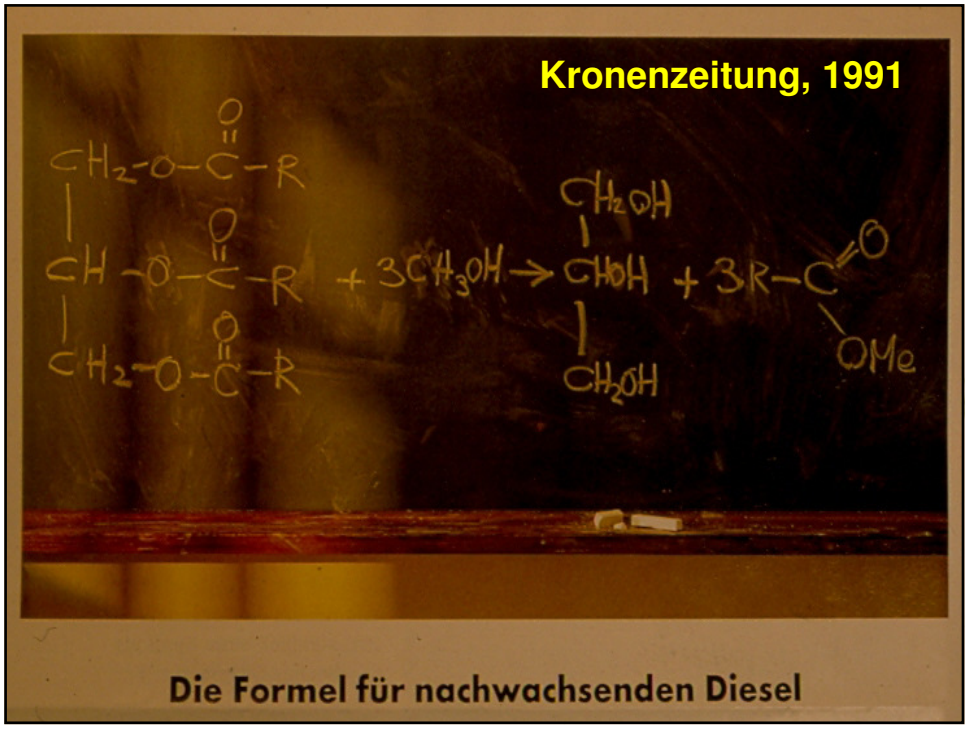
Prion protein
responsible for
BSE disease:

Destruction during
Biodiesel process?

European Food Safety Authority (EFSA)

The Scientific Panel on Biological Hazards concludes
that the Biodiesel process as described (BDI)
is considered as safe for treatment
and use of ABP of category 1

Algae for Biodiesel Production



History of Alcoholysis of Triacylglycerols

1852 *P.Duffy: Alcoholysis of fats: J.Chem.Soc.*

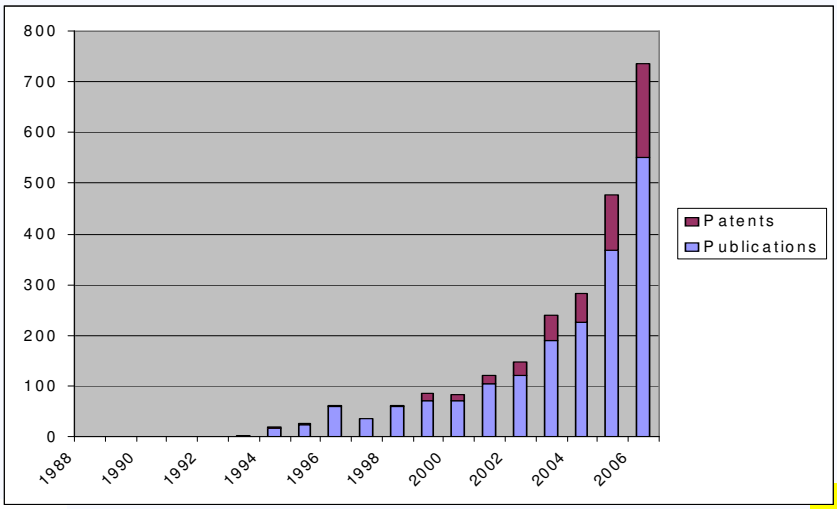
1944 *G.B.Bradshaw: US 2,360,844*
preparation of pure glycerol: 2-step reaction

1950 ff Fatty alcohol production for nonionic detergents
high temperature and pressure process
240 °C; 100 bar; $NaOCH_3$; distillation

1986 *Mittelbach et al. AT 386.222*
low temperature and pressure process for biodiesel production: KOH; purification with IER

1990 ff over 200 patents on biodiesel production

Citations in Chemical Abstracts „Biodiesel“



Biodiesel Production Technologies

1) Single Feedstock Technologies

Feedstock	→	Fully refined vegetable oils, FFA < 1 %
Catalyst	→	$NaOCH_3$, NaOH, KOH
Reaction conditions	→	40-100 °C, batch or continous
Purification ME-Ester	→	water washing, drying, no distillation
Glycerol treatment	→	removal H_2O+MeOH, opt.: distillation
Capacity	→	500 t – 250.000 t/a

Biodiesel Production Technologies

2) Multi Feedstock Technologies

FFA: up to 100 %

Feedstock	Crude vegetable oils, animal fat, waste oils
Catalyst	Preesterif.: H^+; Transesterif.: KOH
Reaction conditions	40-60°C, batch or continous
Purification ME-Ester	water washing, drying, distillation
Glycerol treatment	acidification, salt separation: crude glycerol
Capacity	5.000 t – 50.000 t/a

Homogenous Catalysts for Transesterification

Type of Catalyst	Comments
Sodium hydroxide	Cheap, disposal of residual salts necessary
Potassium hydroxide	Reuse as fertilizer possible, fast reaction rate, better separation of glycerol
Sodium methoxide	No dissolution of catalyst necessary, disposal of salts necessary disposal
Potassium methoxide	No dissolution of catalyst necessary, fertilizer, better separation of glycerol, high price

Acidic Catalysts for Esterification

Type of Catalyst	Comments
Conc. sulphuric acid	Cheap, decomposition products, corrosion
p-Toluene-sulphonic acid	High price, recycling necessary
Acidic ion exchange resins	High price, continuous reaction possible, low stability

New Trends: Heterogenous Catalysts

Metal oxides (Mg, Ca, Al, Fe)
Carbonates: $CaCO_3$
Ion exchange resins (acidic, alkaline)
Enzymes
Silicates

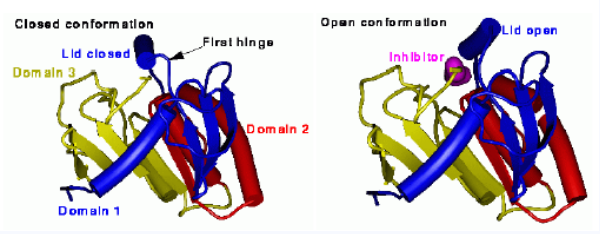
\+ easy separation, reusable
pure glycerol, no side products (salts)
first industrial application 2006

\- high temperature and pressure, high investment costs

New Trends: Enzymes as Catalysts

Lipases (Triacylglycerolhydrolases)

main task: lipid hydrolysis
in organic solvents:
esterification, transesterification
Alcoholysis of sunflower oil with MeOH, EtOH
Mittelbach et al., 1990



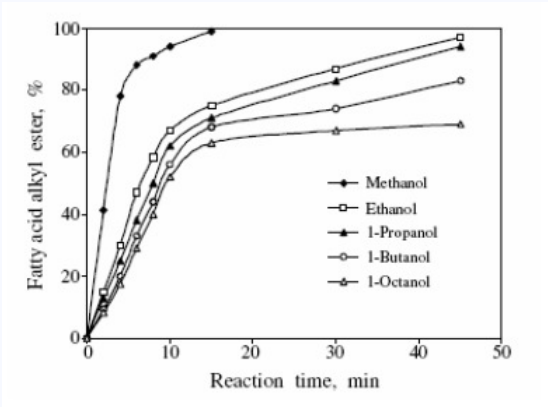
Enzymes as Catalysts: Main Advantages

- Heterogenous catalysts, immobilization, reusable
- Saving of chemicals
- Easy purification of glycerol
- Catalysis of esterification as well as transesterification
- Mild reaction conditions

Alcoholysis Without any Catalyst Supercritical Conditions

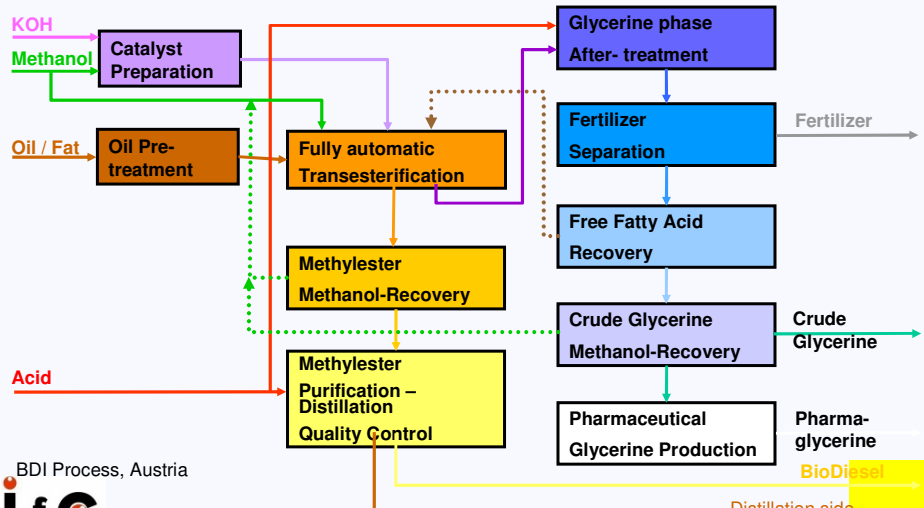
	Base catalyzed methanolysis	SCM method
Catalyst	Alkali hydroxides, alcoholates	none
Methanol amount	Slight excess	High excess
Reaction temperature [°C]	20-60	250-300
Reaction pressure [MPa]	0.1	10-25
Reaction time [min]	30-120	7-15
Free fatty acids	soaps	FAME, water
Purification of glycerol	Salt formation	No salts, possible condensation products (methyl ethers)
Energy consumption	low	high

Alcoholysis Without any Catalyst Supercritical Conditions



A.Demirbas, 2006

Multi-Feedstock Production Scheme (simplified)



BDI Process, Austria

Thank You for Your Attention !