Innovative Biodiesel Feedstocks

Martin Mittelbach
martin.mittelbach@uni-graz.at

Institute of Chemistry (IFC)

Department of Renewable Resources
University of Graz
A-8010 Graz
Austria

IEA Workshop „Transport Biofuels Research in Austria“
Vienna, September 9, 2008

food
Not fuel

Biodiesel Production 2007

Source: EBB, NBB, EurObserver

Raw Material Sources for Today´s Biodiesel Production, Worldwide

Raw Material Sources for Tomorrow´s Biodiesel Production, Worldwide ???

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

All 150 City Buses in Graz are running with 100 % Biodiesel from Used Frying Oil

Potential of Used Frying Oil in EU-27

Per Capita Disappearance of Fats and Oils

Netherlands	88 kg/a
Belgium	62 kg/a
Germany	42 kg/a
Austria	30 kg/a
EU-15	43 kg/a
USA	45 kg/a
Brazil	22 kg/a

Maximum Collectable Amount of Recycled Frying Oil

approx. 5 kg/p.a.
population: 493 mill.
2.5 mill. t/a
approx 1 % of transport fuel demand

Potential for Biodiesel-Production in EU-27

Maximum Potential on Rendered Fat:
2,000,000 t/a

Demand for Transport Fuel EU-27:
300,000,000 t/a

Substitution: **0.7 %**

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

Jatropha curcas L
The Biodiesel Crop in the Future???

Jatropha curcas Hype

jatros (griech.) = physician
trophe (griech.) = food

Useful links:

www.jatropha.de
www.jatropha.world.org

Figure 2. *Global indication of the most suitable climate conditions for the growth of Jatropha (J.* curcas *L.) (30° N, 35° S) and Oil palm (*Elaeis guineensis *Jacq.) (4° N, 8° S).*

Source: *www.jatropha.de*

Jatropha Production Worldwide

India:

Available areas: 50 mill ha

(20 % of diesel demand in 2011)

China:

Goal: 11 mill. ha until 2010

Indonesia:

Potential: 25 mill ha

Africa:

500.000 ha under cultivation ??

M.Mittelbach, Bogor 2008

M.Mittelbach, Bogor 2008

M.Mittelbach, Malaysia 2008

Symposium on Biofuel and Industrial Products from *Jatropha curcas* and other Tropical Oil Seed Plants

Managua / Nicaragua
23 - 27 February 1997

UNI GRAZ

Toxic Principles of *Jatropha Curcas* L.

Phorbol esters:

mainly in the oil; esters of tigliane diterpenes
tumor promotion, cell proliferation, activation of blood platelets, lymphocyte mitogenesis, inflammation

Curcin:

mainly in the oil cake; Ribosome-inactivating protein

Non-toxic varieties found in Mexico

Identification of 6 New Phorbol Esters

W.Haas, H.Sterk, M.Mittelbach: *J. Nat. Prod.* **2002,** *65,* 1434-1440

HPLC:

Toxic variety

Non toxic variety

HPLC:

Oil:

Toxic variety

Methyl Ester:

After trans-esterification

Possible Risks of Jatropha

- High yields need agricultural production
  (water, fertilizer, pest control)
- Toxic seeds have to be processed in specified plants
  (labelling ?)
- Harvesting is laborious, long harvesting period
- Detoxification of oil cake would improve the economy
- Research on non-toxic varieties, plant breeding, GM

Castor (*Ricinus communis* L.)

World production: 0.6 mill. t/a

- **Occurrence**

  Central Africa

  India

  Central and South America

- **Seeds**

  40-50% Oil

  14-22% Proteins

- **Use**

  Glue, Cosmetics,
  Lubricants, Dyes

Castor: Unusual Compounds

a) Ricin

Lectine

LD_{50}: 0,02 mg/kg

b) Ricinolic acid

Coconut (*Cocos nucifera* L.)

- **Occurrence**

  Philippines, Indonesia, Sri Lanka, Malaysia, Thailand, Mexico, Vietnam,

  Ivory Coast

- **Use**

  Detergents, Food

World production: 5 mill.t/a

Distillation Properties of Coconut ME Blends

Distillation Properties of Coconut ME Blends

Pongamia Pinnata L.
Karanja, Indian Beech Tree

Hevea Brasiliensis, Rubber Tree

Hevea Brasiliensis, Rubber Seed

Fatty Acid Distribution of Non Edible Oils

	C-16:0	C-18:0	C-18:1	C-18:2	C-18:3	Others	Iodine Nr
Rape seed	3-5	1-2	55-65	20-26	8-10		96-117
Jatropha curcas	12-17	5-10	37-63	19-41		1-2	93-107
Pongamia pinnata	3-8	2-9	44-71	10-18		15-20	80-96
Rubber seed	7-8	9-10	28-30	33-35	20-21		121-145
Sal	5-9	34-48	34-45	2-3		6-12	33-45
Castor	1-2	1-2	3-4	5-6	0.5-1	87-88	82-90
Tobacco seed	11	3.5	14.5	69.5			136-146

Microalgae for Biodiesel Production

Oil Yields: kg/ha

Corn:	145	Poppy sead:	978
Cotton:	273	Rapeseed:	1000
Soybean:	375	Castor:	1188
Mustard:	481	Jojoba:	1528
Camelina:	490	Jatropha:	1590
Safflower:	655	Macadam:	1887
Rice:	696	Avocado:	2217
Sunflower:	800	Coconut:	2260
Peanuts:	890	Oilpalm:	-5000

Algae: 20,000 – 100,000 ????

Economy of Algal Biodiesel

Y.Chisti, Trends in Biotechnology, 2008

Thank You for Your Kind Attention!