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"New and Specific Oils for Biodiesel Production – Non-food Oilseed Crops for Semi-arid Regions "

prepared for the

COMPETE Workshop

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Worldwide there is a wide spectrum of different vegetable oils available

There are many opportunities and options in feedstock supply, - evaluation has do be done however very carefully for:

- technical suitability and quality issues
- availability in volume
- logistic aspects and transport options
- sustainability in production and supply
- life cycle of an oilseed crop
- improvement potential by proper breeding
- competitiveness with other crops in the region

► **assurance of high quality feedstock supply is step no. 1 !**

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The biodiesel standard is influenced by type of oil

	pr EN 14214 Fatty-acid-methyl-ester (FAME)		22.10.02
	Parameter	Range	Unit
	Ester content	≥96.5	%m/m
	Density at 15°C	860 – 900	kg/m³
	Viscosity at 40°C	3.5 – 5.0	mm²/s
	Viscosity (-20°C)	≤ 48	mm²/s
	Flash point	≥110	°C
CFPP →	CFPP	see EN590	°C
Sulphur →	Sulfur content	≤ 10.0	mg/kg
	CCR / 10% distill. residue	≤ 0.30	%m/m
Cetane →	Cetane number	≥ 51.0	-
	Sulfated ash	≤ 0.02	%m/m
	Water content	≤ 0.05	%m/kg
	Total contamination	≤ 24	mg/kg
	Copper corrosion (3h at 50°C)	class 1	rating
Oxidation stability →	Oxidation stability	≥ 6.0	h
→	Thermal stability	?	h
→	Storage stability	-----	----
	Acid number	≤ 0.50	mg KOH/g
Iodine no. →	Iodine number	≤ 120	-
Polyunsaturated ME →	Polyunsaturated methyl esters: C 18:4 +	≤ 1.0	%m/m
→	Linolenic acid methyl ester	≤ 12.0	%m/m
	Methanol content	≤ 0.20	%m/m
	Monoglyceride content	≤ 0.80	%m/m
	Diglyceride content	≤ 0.20	%m/m
	Triglyceride content	≤ 0.20	%m/m
	Free glycerol	≤ 0.02	%m/m
	Total glycerol	≤ 0.25	%m/m
	Group I metals (Na/K)	≤ 5.0	mg/kg
	Group II metals (Ca-Mg)	≤ 5.0	mg/kg
Phosphorus →	Phosphorus content	≤ 10.0	mg/kg

▶ criteria influenced by origin of oil

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Innovative biodiesel

Property trade-offs: short-chain vs. long-chain

properties:	SHORTCHAIN	←		→	LONGCHAIN
1. oxygen content	higher	←		→	lower
emissions	*reduced*	☺	PM + soot		*increased*
caloric value	*lower*		performance	☺	*higher*
combustion	*improved*	☺			*worse*
2. boiling line	lower	←		→	higher
emissions	*reduced*	☺	PM, HC		*increased*
3. CFPP	lower	←		→	higher
winter operability	*better*	☺	°C		*worse*

Property trade-offs: saturated vs. unsaturated

	SATURATED	←		→	UNSATURATED
4. CFPP	higher	←		→	lower
winter operability	*worse*		°C	☺	*better*
5. Cetane	higher	←		→	lower
engine performance	*improved*	☺			*lower*
6. Iodine value	lower	←		→	higher
oxidation stability	*better*	☺			*worse*
polymerisation	*lower*	☺			*higher*

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ranked by IV

all the world's oilseeds

Can we find the ideal fatty acid profile ?

FAME	Labornr:	C 8:0	C 10:0	C 12:0	C 14:0	C 16:0	C 18:0	C 20:0	C 22:0	C 24:0	C 18:1	C 22:1	C 18:2	C 18:3	Gesamt: [%]	Iodine Value [g I2/100g FAME]
Coconut Fat - ME	05-308	7,0%	5,7%	42,4%	18,1%	11,3%	4,2%				8,7%		2,5%		100,0%	11,8
Acrocomia Nut Oil - ME	04-358	5,4%	4,5%	38,2%	8,8%	8,2%	3,3%				27,9%		3,6%		100,0%	30,2
Palm Fat - ME	05-141				1,3%	44,7%	5,4%	0,5%			37,2%		10,8%		100,0%	50,8
Lard - ME	04-319			0,4%	2,3%	29,6%	20,0%				33,2%		13,1%	1,5%	100,0%	55,0
Animal Fat - ME	05-107				2,3%	29,8%	17,1%				37,7%		11,5%	1,7%	100,0%	56,8
HO Sunflower Oil - ME	05-102					5,2%	4,2%		2,0%		78,7%		10,0%		100,0%	84,9
Soy Oil - ME HighOleic	05-710					5,4%	4,1%				81,3%		3,8%	5,3%	100,0%	90,4
Jatropha Oil - ME	05-728					17,7%	7,9%				37,8%		36,6%		100,0%	95,9
Used Frying Oil - ME high visc.	05-344					16,5%	5,9%	0,9%	1,2%		40,9%		26,8%	7,9%	100,0%	102,1
Canola Oil - ME	05-693					5,6%	2,4%	1,0%	0,8%		63,6%		23,4%	3,2%	100,0%	103,6
Used Frying Oil - ME low visc.	05-339					14,3%	5,0%	1,0%	1,2%		41,6%	0,8%	27,4%	8,8%	100,0%	106,8
Soy Oil - ME MidOleic	05-709					11,1%	5,0%	0,6%	0,9%		43,7%		35,5%	3,1%	100,0%	107,1
Rapeseed Oil - ME	05-333					6,0%	2,4%	0,9%			59,3%		28,6%	2,7%	100,0%	107,8
Milk Thistle Oil - ME	05-178					10,0%	6,2%	4,1%	3,9%	1,2%	22,7%		50,7%	1,2%	100,0%	110,4
Rapeseed Oil - ME	05-330					6,9%	2,5%	1,0%	0,8%		58,0%		20,9%	9,8%	100,0%	111,8
HEAR OIL - ME	05-093					4,3%	1,2%	0,9%	1,0%		14,0%	47,2%	15,5%	15,8%	100,0%	114,4
Rapeseed Oil - ME	04-260					6,3%	2,3%	0,9%			57,9%		22,2%	10,4%	100,0%	115,4
Rapeseed Oil - ME	05-348					5,7%	2,3%	0,9%	0,7%		57,1%		22,7%	10,5%	100,0%	115,9
Soy Oil - ME LowLin	05-701					12,1%	6,1%	0,5%	0,7%		24,2%		54,9%	1,5%	100,0%	119,8
Sunflower Oil - ME	05-078					8,0%	4,7%		1,2%		28,9%		56,5%	0,7%	100,0%	124,6
Soy Oil - ME	05-314					13,0%	4,9%	0,5%	0,8%		23,9%		49,6%	7,3%	100,0%	125,5
Rapeseed Soy Oil-ME	05-108					12,3%	5,6%		0,7%		22,1%		52,1%	7,3%	100,0%	128,3
Soy Oil - ME Regular	05-700					12,5%	5,2%				22,3%		50,2%	9,8%	100,0%	131,8
Camelina Oil - ME	04-321					6,7%	3,0%	2,3%	0,7%		14,3%	6,5%	18,2%	48,4%	100,0%	175,0
Linseed Oil - ME	05-166					6,1%	4,6%				17,5%		15,9%	55,9%	100,0%	188,9

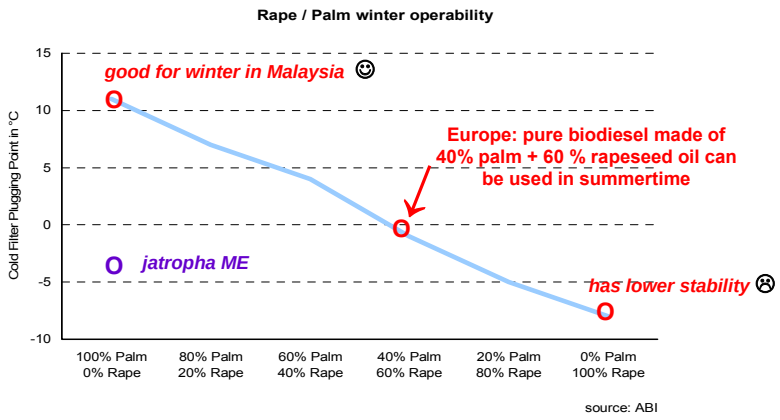
Actions for quality improvement of Biodiesel :

Fatty acid composition of an oil can be improved by

- **targeted breeding for dedicated oilseed plants**
- **appropriate blending of various oils**

► **further improvements are necessary and can be expected**

Optimise feedstock cost by intelligent blending



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balancing pros and cons

What are the selection criteria ?

Iodine number (IN): indication for *fuel stability*, negatively influenced by higher number of double-bonds in fatty acids (FA).

Net calorific value: indication for *energy content*, negatively influenced by higher content of oxygen e.g. in short-chain fatty acids.

Cold filter plugging point (CFPP): indication for *winter operability*, negatively influenced by higher content of saturated FA.

Cetane number: indication for *ignition behaviour*.

Distillation curve: indication for *smoothness of combustion*.

A clever blend of various oils can result in the "super-biodiesel"

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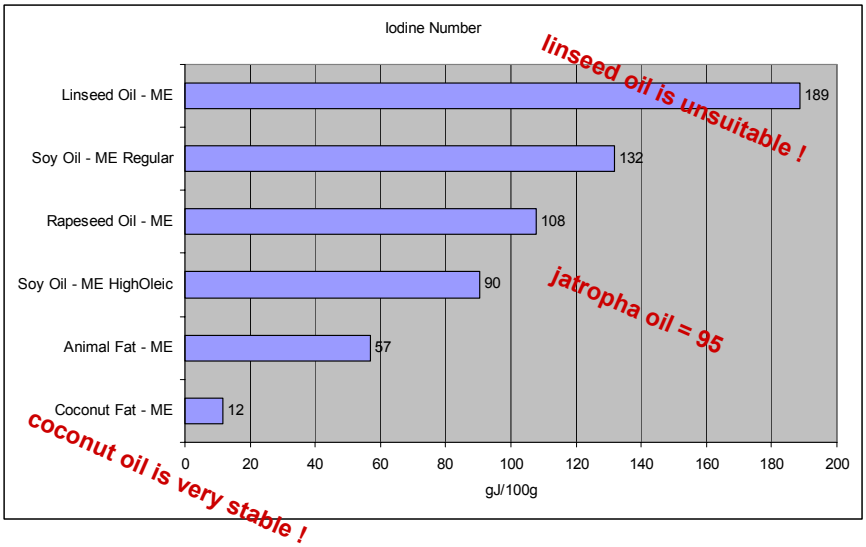
Iodine number (IN) – indication for stability



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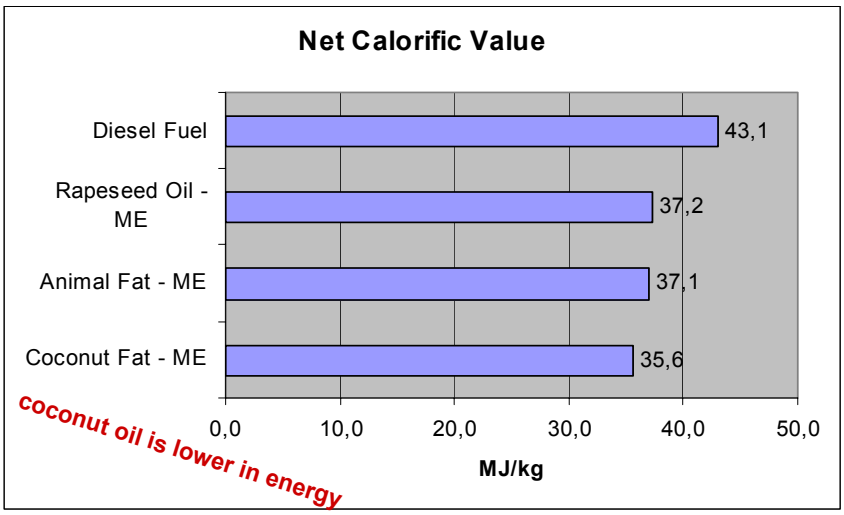
Net calorific value – energy content



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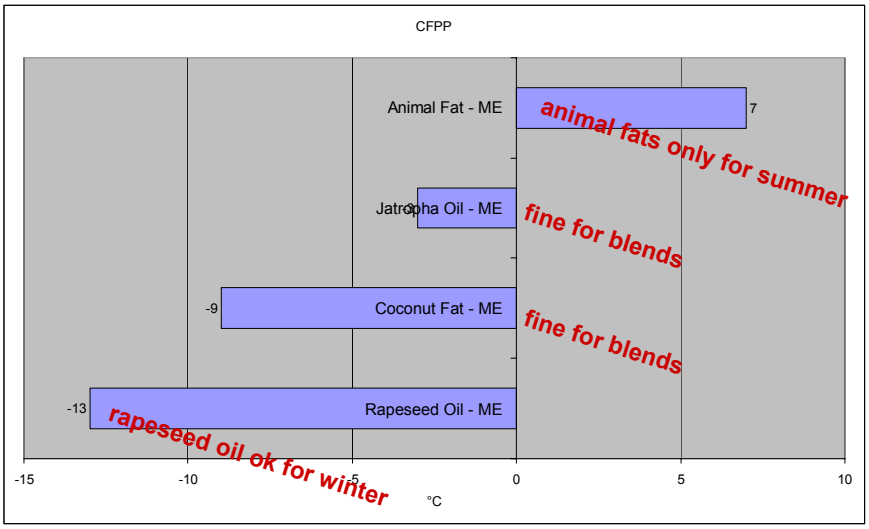
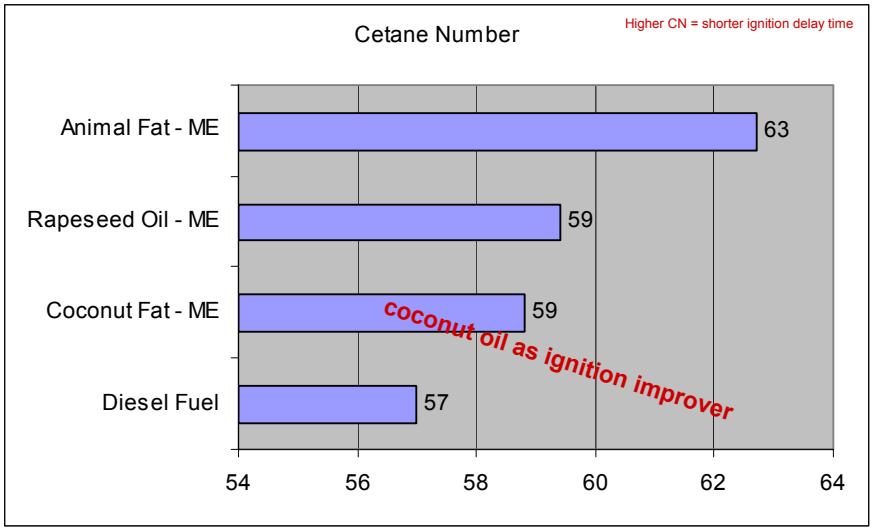
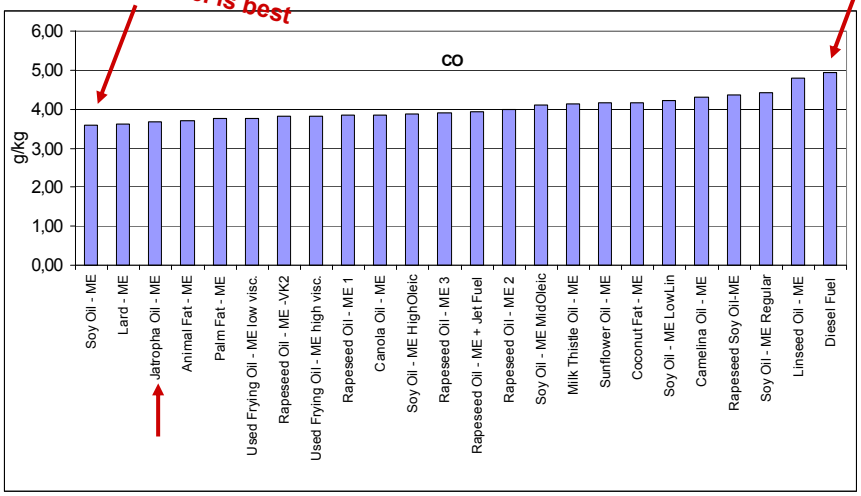
Cold filter plugging point – winter operability



Cetane number



CO emissions



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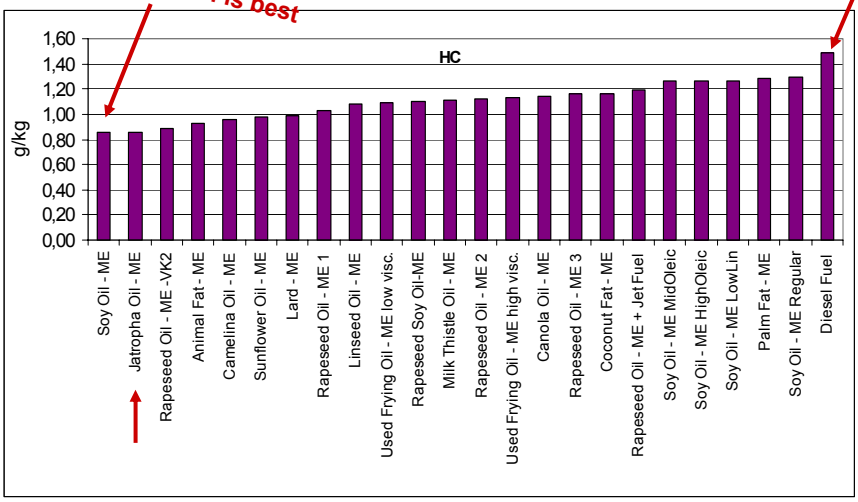
HC emissions

soy biodiesel is best

all biodiesel better than DK



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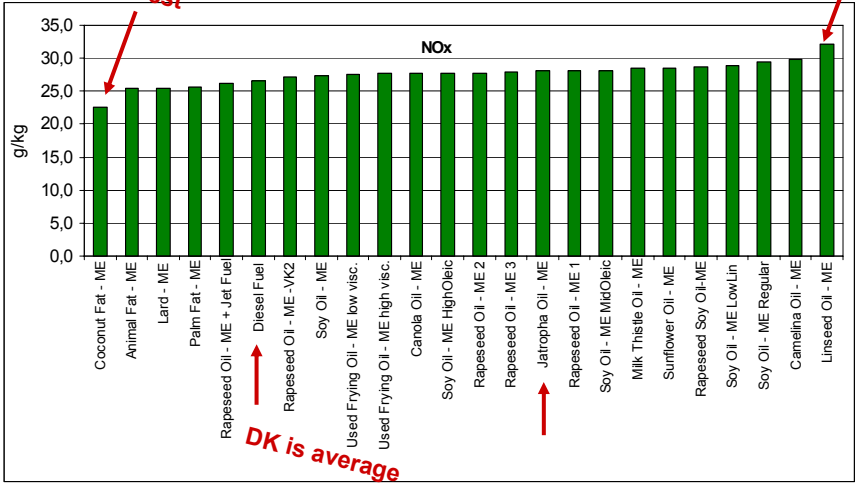
NO_x emissions

coconut biodiesel is best

linseed biodiesel is worst



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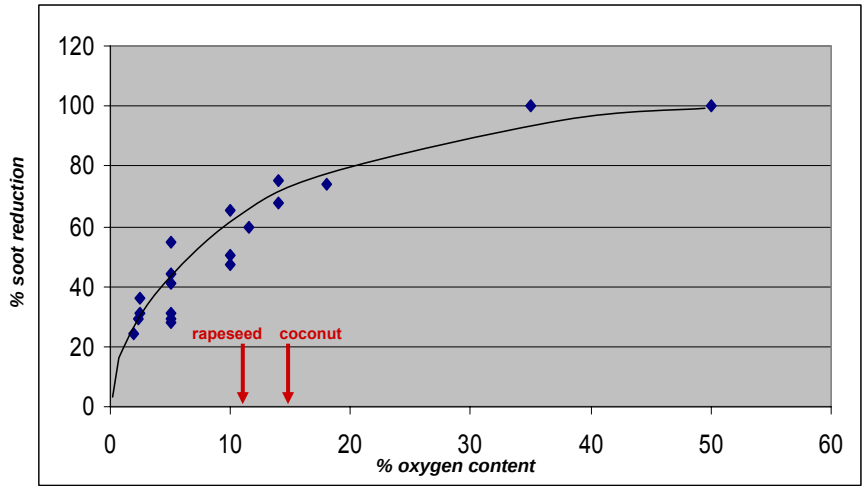
Correlation: the higher the oxygen content the lower the soot emissions



Source: TU Graz

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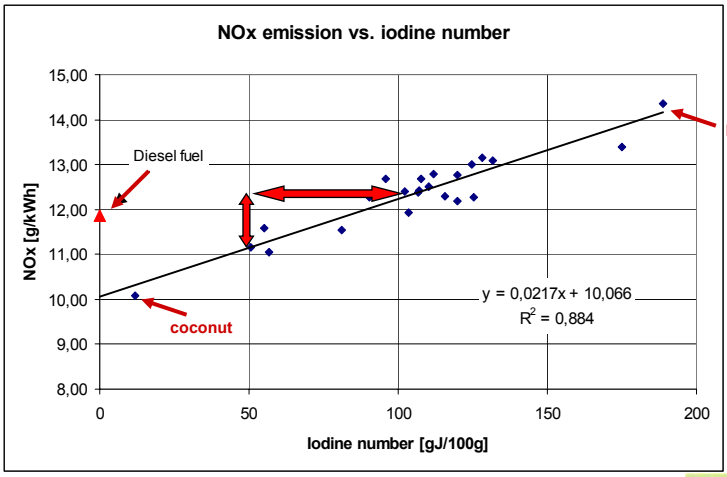
Correlation: the lower the Iodine number the lower the NO_x emissions



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Conclusion: balancing all advantages and risks, opportunities and risks of new non-food feedstocks we can state that …

1. … presently used food oils do not have the best suitability, while some non-food plants appear to be more attractive;

2. … there is a wide of opportunities of not yet discovered and researched non-food oilseed crops;

3. … their properties can be improved by proper breeding by traditional as well as gene modification methods for
*** optimised fatty acid profile leading to "super-biodiesel",**
*** improved suitability for marginal soils,**
*** ability to be grown in semi-arid climate zones**
*** at reasonable yields.**