

High Performance in Non-Food Applications

High Oleic Oils



GreenTech 2002 with
5th European Symposium Industrial Crops and Products

At the Floriade, 23-25 April 2002

S e r v i c e s

- **Business Development Strategies:
⇒ Products, Markets & Technologies**
- **Co-Operation: Partners & Strategies**
- **Oleochemistry: Processes & Applications**
- **HO Seed Cultivation & Oil Supply**
- **Market Study High Oleic Oil**

General Criteria for Oil Selection / Use

- **Total Costs:** purchase, maintenance, handling, storage, disposal ...
- **Performance:** specific parameters / properties for each application
e.g. Lubricants: friction reduction / anti wear, heat transfer ...
- **Lifetime:** shelf life, consumption, extension, oxidation behaviour ...
- **Supply Raw Material:** availability, security, quality, competition ...
- **Product Safety:** toxicity, health hazards, flashpoint ...
- **Environmental Aspects:** biodegradability, toxicity, climate change
- **Disposal:** recovery / waste management, legal affairs...
- **Innovation Aspects:** EINECS, patents, exclusivity...

⇒ **HO Oils offer excellent Business Opportunities !**

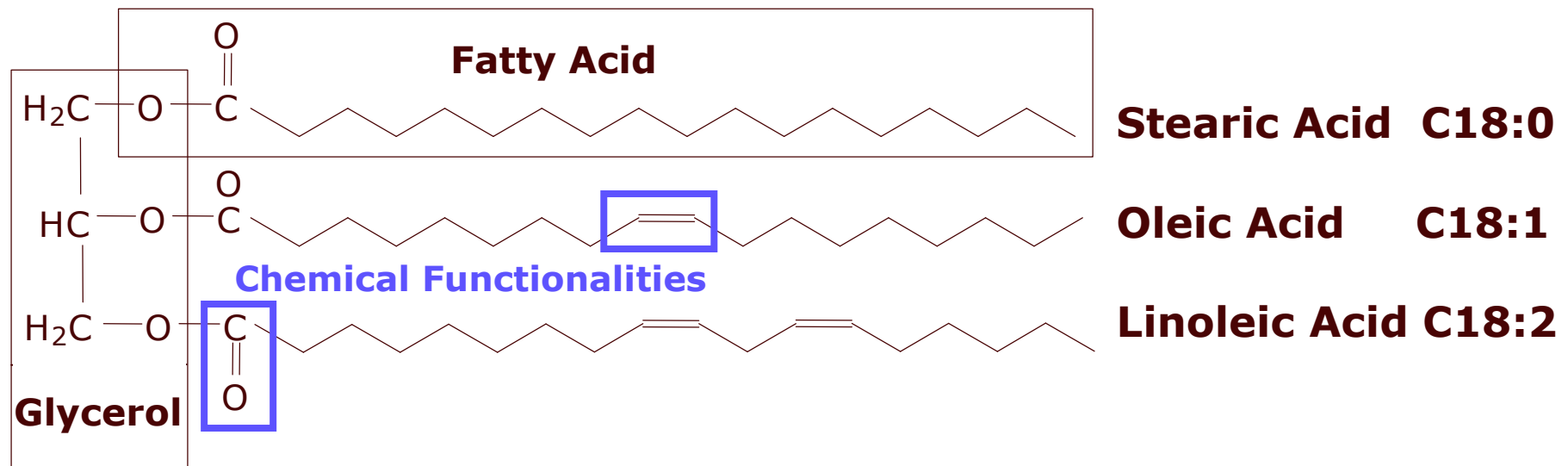
Fatty Acid Characterization

Fatty Acid		Low-Temp. Behaviour	High-Temp. Behaviour	Oxidative Stability	Availability	Costs
Caprylic	C8 :0	+ / 0	+	++	0	--
Capric	C10:0	+ / 0	+	++	0	--
Lauric	C12:0	0	++	++	+	0 / -
Myristic	C14:0	-	++	++	+	0 / -
Palmitic	C16:0	-	++	++	++	+
Stearic	C18:0	--	++	++	++	++
Oleic	C18:1	+ / 0	+	+	++	+
Linoleic	C18:2	+	-	-	+	0 / -
Linolenic	C18:3	++	--	--	0	0

⇒ **C18:1 - Convincing compromise between technical & economical constraints**

What`s Unique with HO Oils ?

Compared to Other Oils & Fats ?



- Ordinary oils & fats have a mixed fatty acid composition
- HO Oils (Definition): > 80 % Oleic Acid (C18:1)

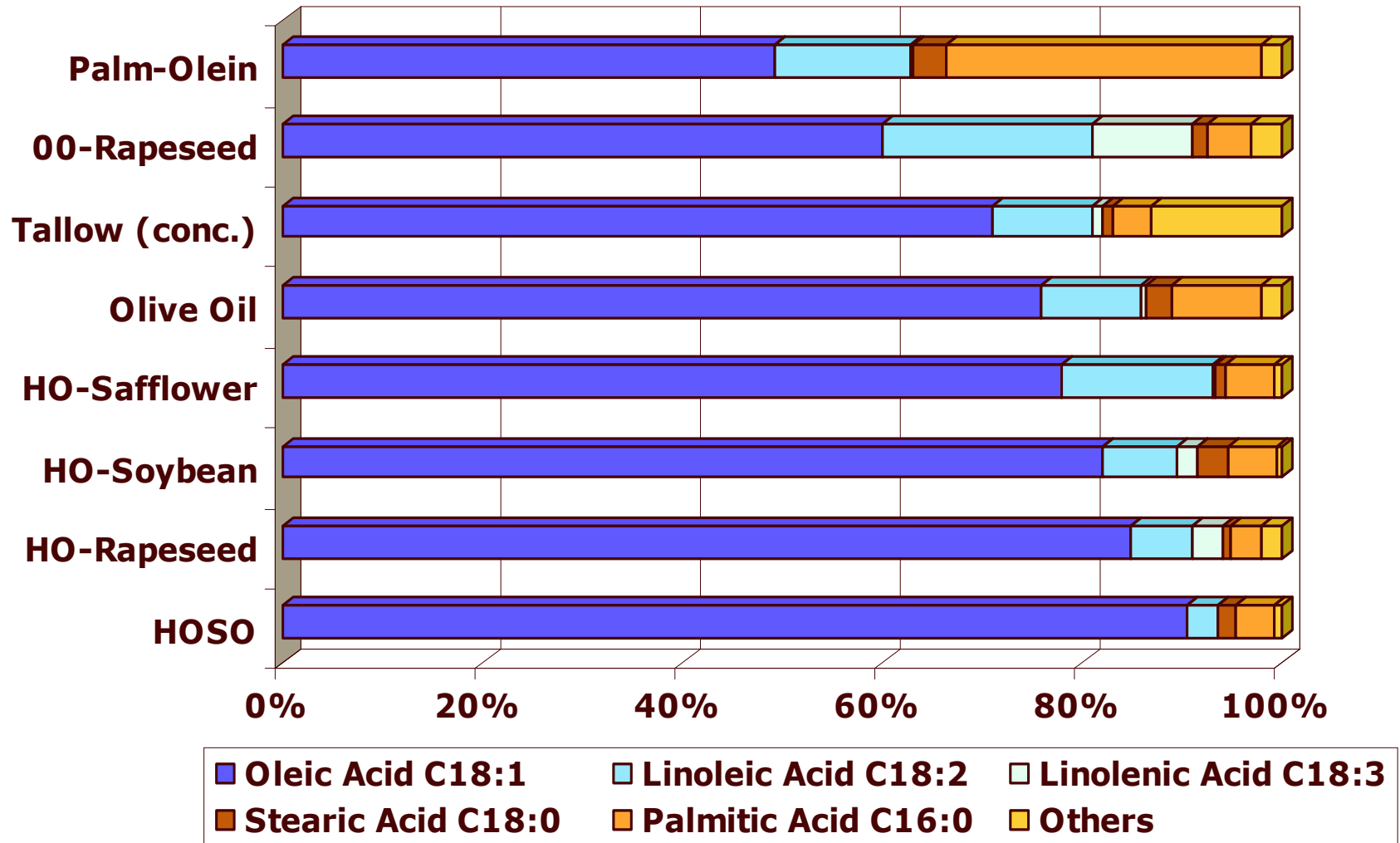
⇒ **Defined Chemical & Physical Characteristics !**

Oleic Acid Sources

Oleic Acid Source	Oleic Acid C18:1	Linoleic A. C18:2	Linolenic A. C18:3	Stearic A. C18:0	Palmitic A. C16:0	Others
HO Sunflower	80-92	3-10	0	2	4	1
HO Rapeseed	75-85	6-11	3	1-2	4	1,7
HO Soy	75-85	2-5	2-5	3-5	6-10	0,7
HO Safflower	75-80	14-16	0,3	1	5	0,7
Olive Oil	73-78	9-11	0,5	3-5	10	0,7
Rapeseed Oil	57-60	19-22	10	1-2	4,5	2-3
Palm Oleine (Oil)	40-42	11-12	0,4	4,4	39,8	1-2
Tallow (Fat)	36-40	4	0,7	20	26	11

HO Sunflower Oils (HOSO) with highest C18:1 content

Fatty Acid Composition



HO Oils:

Properties & Benefits

For all kinds of applications:

- ✓ **defined properties / reactivity / purity**
- ✓ **high oxidative stability**
- ✓ **reduced rancidity / light-, oxygen- and temp. sensitivity**
- ✓ **very low evaporation loss (VOC, inhalation)**
- ✓ **extended shelf life**
- ✓ **high biodegradability, low toxicity**
- ✓ **dermatological health aspects (skin compatibility)**
- ✓ **odorless & colorless**
- ✓ **vegetable resource image: kosher & "BSE-free"**

narocon HO Market Study

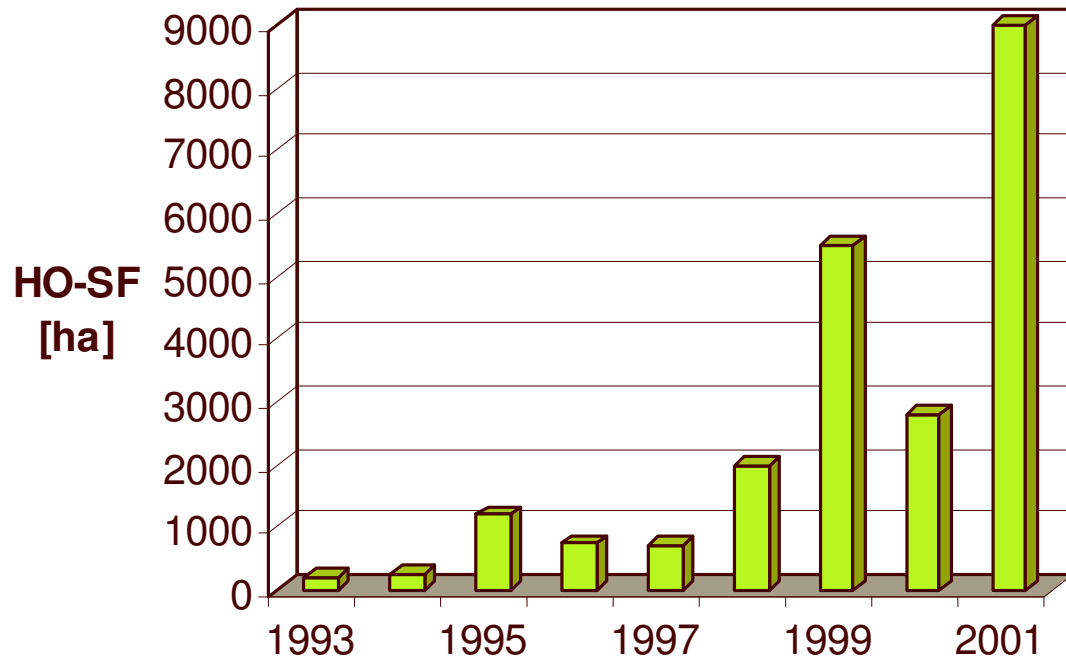
- Production (1998-2000) -

Oleic Acid Source	World	EU	D	Main Supplier
HO Sunflower Oil	300	50-100	5-10	USA (100), F (50), ARG, I, ES
HO Rapeseed	< 10	< 1	0	USA, Kanada
HO Soybean	< 10	0	0	USA
HO Safflower	10-25	0	0	USA, AUS
Olive	2450	2200	0	ES, I, Gr, Tun

- **HO SF:** industrial volumes available, strong growth forecasted
- **HO Ra / HO Soy:** breeding (GMO), (pilot-) cultivation in USA
- **HO Safflower:** low hectare oil yield
- **Olive (<80%):** mainly for food purposes, difficult to enlarge area

HOSF Cultivation in Germany:

- Growth continued -



Results Pilot Project

- ⇒ Production of 80/90+ is large scale feasible
- ⇒ Appr. 1000 kg oil yield per hectare
- ⇒ Higher cultivation risk compared to conv. SF
- ⇒ For 90+ an extended QM has to be set up!

Cult. Area [ha]	1994	1995	1996	1997	1998	1999	2000	2001
Germany	260	1.200	737	700	2.000	5.500	2.800	9.000

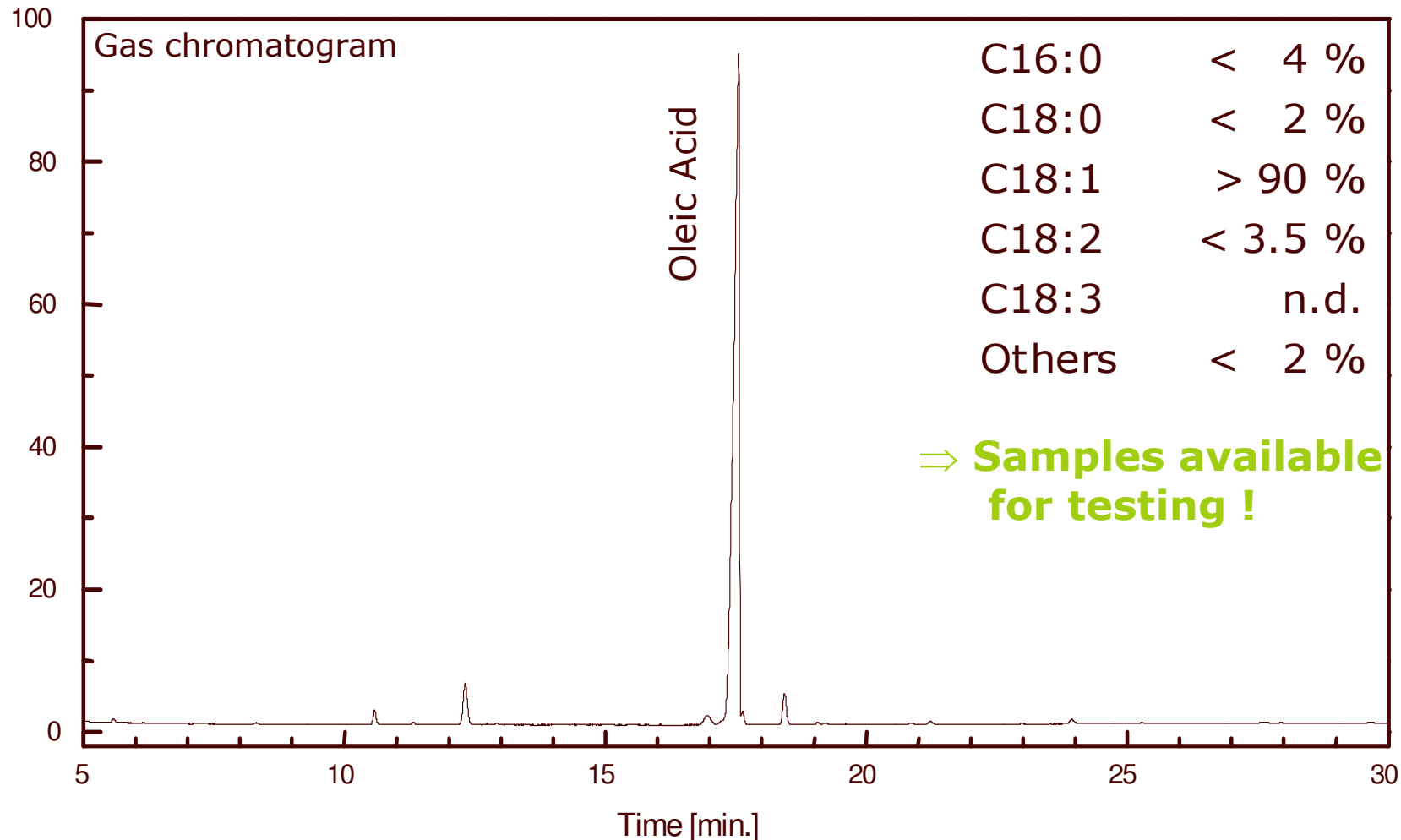
HOSO Types: Different Levels of Performance

Fatty Acid [%]		80+	90plus [®]	old SF Type
Palmitic A.	C16:0	4.0 - 4.5	3.5 - 4.0	5.0 - 6.0
Stearic A.	C18:0	2.5 - 3.0	1.0 - 1.5	4.0 - 5.5
Oleic A.	C18:1	80.0 - 83.0	90.0 - 92.0	22.0 - 25.0
Linoleic A.	C18:2	9.0 - 11.0	2.5 - 3.5	60.0 - 66.0
Linolenic A.	C18:3	0	0	0
Others		1.0 - 2.0	0.5 - 0.8	0.5 - 1.0

Results in German HOSF cultivation 1999 - 2001

- **80+: Standard Type ("vegetable oleine")**
- **90plus[®]: "New Dimension"**
suits for applications, where conventional **C18:1** products could not be used before

HO Sunflower Oil 90plus®



Oil Purity is the Key for Performance ! (defined properties)

90plus[®] HOSO

- General Description -

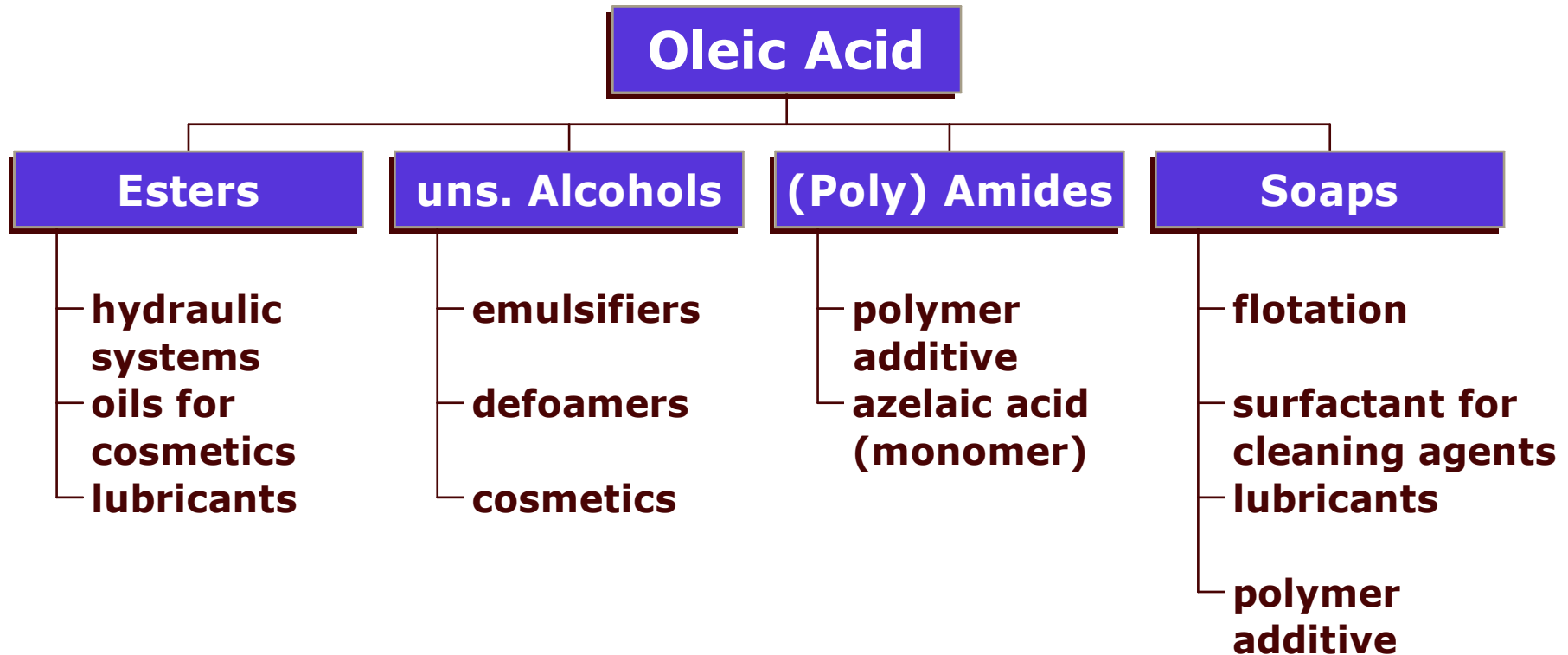
- **Chemical / Physical Properties:**
the very low level of polyunsaturated FA (C18:2/C18:3) and of stearic acid is a unique and main feature !
- **Oil Production:** the Friolex[®] solvent extraction is a new industrial process for oil specialities (10,000-100,000 mt seed volume - 5,000 t 90+ oil available 2002/2003), maintaining the high quality of seed-oil (identity preservat.)
- **New Oleochemistry:** especially for syntheses, 90+ offers many innovative approaches (fine chemicals, polymers)
- **Substitution Potential:** aims at mineral oils products and C8/C10 FA in ester oil applications e.g. TMP (lubes), outperforms all C18:1 applications known so far

Comparison of Oleic A. Sources

	HOSO 80	90	HO- Soy/Rape	Palm- Oleine	Tallow- Oleine	Comments
Availability	+	o/+	--	++	++	production volume
Costs	o	o/-	--	++	+	price range 98-00
Processing	+	++	+	--	-	purification, costs, yield
C18:1-Content	+	++	+	--	-	crude oil
Colour	++	++	++	+	--	best: colourless
Odor	++	++	++	+	--	best: no smell at all
Performance						as high-oleic application!
Syntheses	+	++	+	--	--	Byproducts, Yields
Lubricants	+	++	+	o/-	-	T-Range, Stock.pt., Oxid.
Cosmetics	+	++	- / +	o	-- BSE, TFA, GMO
Food / Frying	++	++	- / +	o/+	o / -	SAFA / PUFA, TFA

➤ **HO Oils offer a great potential in many non-food application**

Sectors of Application for Technical Oleic Acid (> 65%)



Source: Westfechtel / Cognis (adapted)

HO Components for Lubricants

- **HO Products:**
 - native oil "Glyceroltrioleate"
 - linear Monoesters, e.g. Ethylhexyloleate
 - synthetic esters, e.g. TMP-Trioate, complex esters
 - Pelargonic & Azelaic Acid (Di-) Esters
 - Oleylalcohol, Soaps etc...
- **Applications:** loss lubrication products, hydraulic fluids, metal working fluids, 2-stroke engine oils, compressor & vacuum pump oils, demoulding oils, greases etc.
- **Function** - used as: base oil, additive (anti-wear), anti-stick, defoaming agents ...

Lubricants based on HOSO

- ✓ **Excellent friction reduction / anti wear (polar esters)**
- ✓ **performance comparable to mineral oil & synthetic esters in specific applications**
- ✓ **good - excellent oxidative stability**
- ✓ **acceptable low temperature properties**
- ✓ **lower cost than synthetic esters**
- ✓ **higher viscosity grades available**
- ✓ **Cost savings on account of less maintenance-, - man power, - storage- and disposal costs**
- ✓ **Dynamic & sustainable bio-lubricant market growth**

Oxidative Performance

(for lube-products)

	Time [day]	HOSO 90+ rwbd	TMPO (Standard)
Viscosity (kin. 40°C) [mm/s]	0	37,7	46,9
	1	38,4	58,1
	2	38,6	106,8
	6	43,2	not det.
	8	44,5	not det.
Neutr.number [mg KOH/g]	0	1,04	n.d.
	6	0,72	n.d.
	7	0,78	n.d.
	8	0,8	n.d.

**90+ outperforms all commercial TMPO products,
reaches almost C8/C10 ester performance**

T = 130°C, air stream 15l/h, without catalyst, samples in standard formulation (additives)

Compare: **ROBOT** Oxidation Test (ASTM D 2272-85; T=130°C; 6,2 bar O₂; Cu-Catalyst):

HOSO 90+: 340 min - TMPO Standard: 246 min

HO Components in Cosmetic Formulations

- **HO Products:**

**Glycerinmonooleate, Ascorbyloleate, Sorbitanoleates,
Decyloleate, Oleyl alcohol, Oleyloleate, PEG-(Di-)Oleates,
HOSO**

- **Application:**

**Bath oils, sun care products, skin care products,
massage oils, lipsticks, foundations, cremes**

- **Function:**

**emollient, emulsifiers, moisturizing substance,
fat cleansing properties, skin care oil**

HO Oils: Benefits

✓ Processing / Handling:

- pure substance \Rightarrow reduced costs for cleaning operations
- liquid – easy transportation / storage
- high T processing (oxidative stability)

✓ Syntheses:

- exact defined functionality (double bond)
- high product yields & no / less low value by-products

✓ Nutritional Purposes:

- trans fatty acids free (TFA)
- "low-cholesterine" fat (low SAFA), like "best oil" olive oil
- HOSO are non-GMO, kosher and BSE "free"

✓ High Innovation Potential \Rightarrow New Oleochemistry !!

narocon HO Market Study :

HO Oil Market Potential

Application	used as	Market Vol. [t/y]	Potential [t/y]	Comment
Lubricants				
Loss Lubrification	Oil / Ester	750000	100000	15% Share EU
Hydraulic Fluid	Oil / Ester	750000	75000	10% Share EU
Metal Processing	Oil / Ester	500000	50000	10 % Share EU
Others	Oil / Ester	--	60000	
Plastics	Oleic A.-Deriv.	33 Million	70000	Monomers & Addit.
Cosmetics	Oil / Ester	--	25000	Emulsifiers, Oils
Others	Oil / Deriv.	--	70000	technic. products
Food Sector	Oil	> 5 Million	400000	Industr./Consumer
Total			850000	mainly Europe

HO Market Development

- Business Opportunities -

- **Sustainable Market Growth** expected (Sectors):
Lubricants, Plastics, Cosmetics, Food and Syntheses
- **Availability:** contracted HO seed cultivation, free oil supply is expected to rise in future
- **Cost Performance:** 80+ HOSO crude oil prices range expected EUR 700 - 900, 90plus Oil from EUR 1100 - 1500
- **New Oleochemistry:** especially for syntheses, 90+ offers many innovative approaches (fine chemicals, polymers)
- **Substitution Potential:** aims at mineral oils, tallow fatty acids (oleine) and C8/C10 in ester oil applications (lubes)

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