Vegetable oils as feedstock for the chemical industry

CBPM Symposium

June 16th, 2022, Rolf Blaauw, Wageningen Food & Biobased Research

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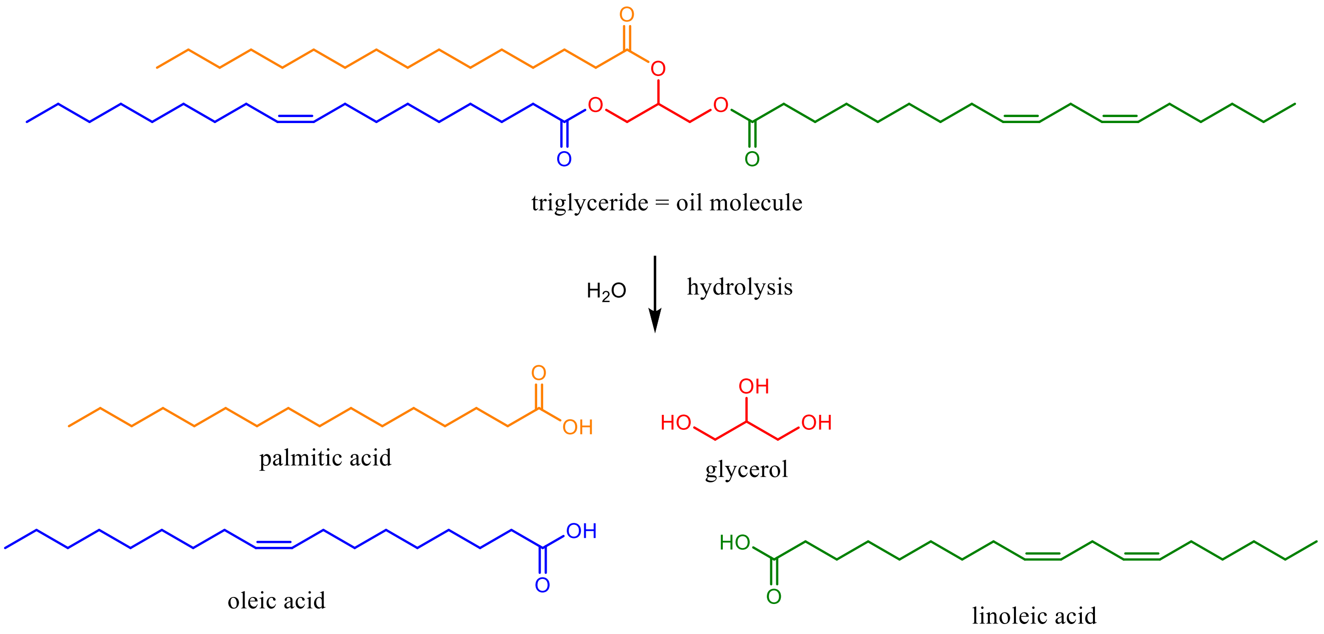
- Concluding remarks

Introduction to vegetable oils

- Tri(acyl)glycerides (TAG): three fatty acids (FA) connected to glycerol



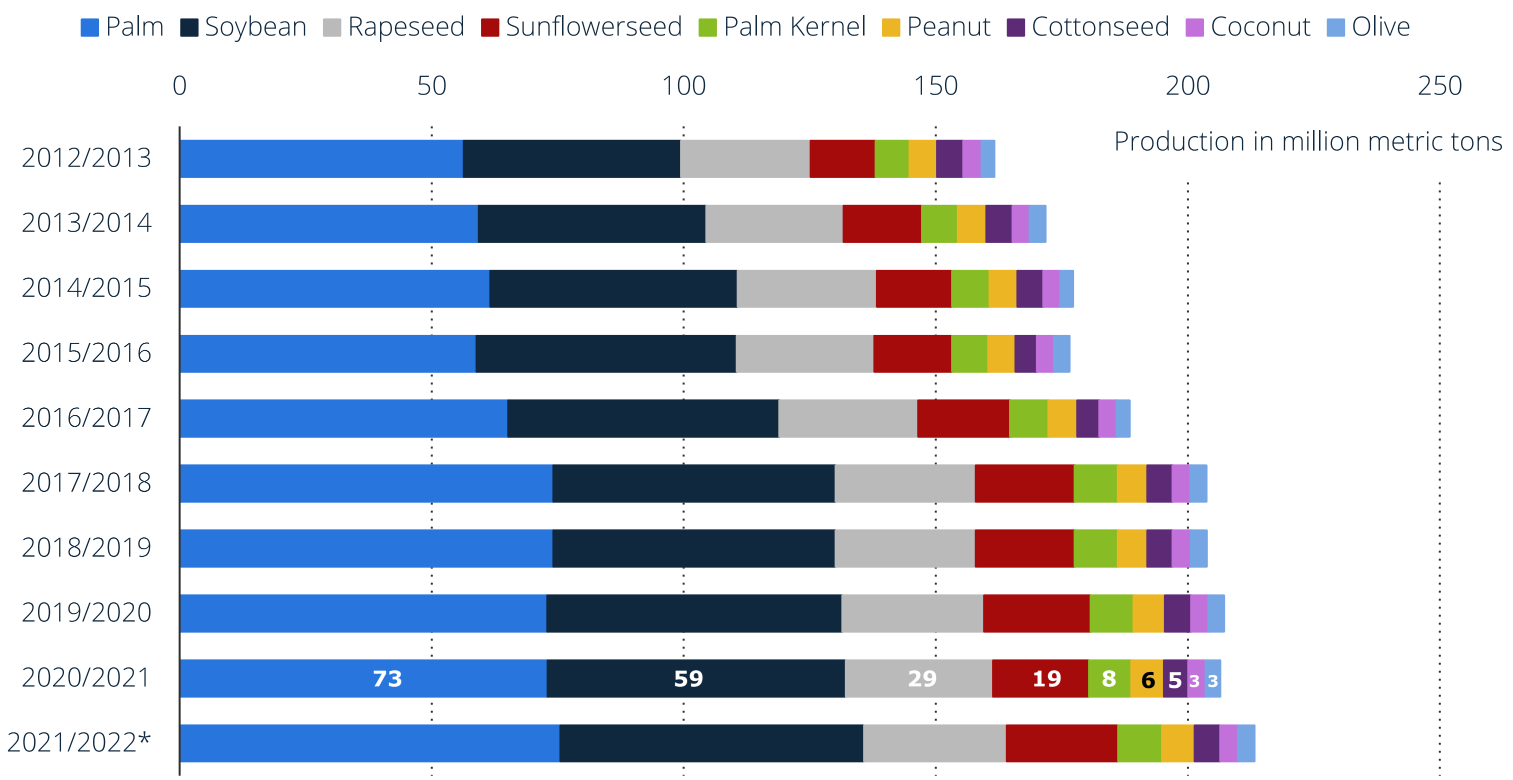
Introduction to vegetable oils

- Oil properties determined by FA composition

FA	Abbrev.	palm kernel	palm (fruit)	rapeseed	soybean
lauric	C12:0	50 %	-	-	-
myristic	C14:0	15 %	-	-	-
palmitic	C16:0	9 %	44 %	4 %	10 %
stearic	C18:0	2 %	4 %	2 %	4 %
oleic	C18:1	14 %	40 %	56 %	23 %
linoleic	C18:2	3 %	10 %	26 %	51 %
linolenic	C18:3	-	-	10 %	7 %
	OTHER	7 %	2 %	2 %	5 %

Cx:y x = carbon chain length
y = number of C=C bonds

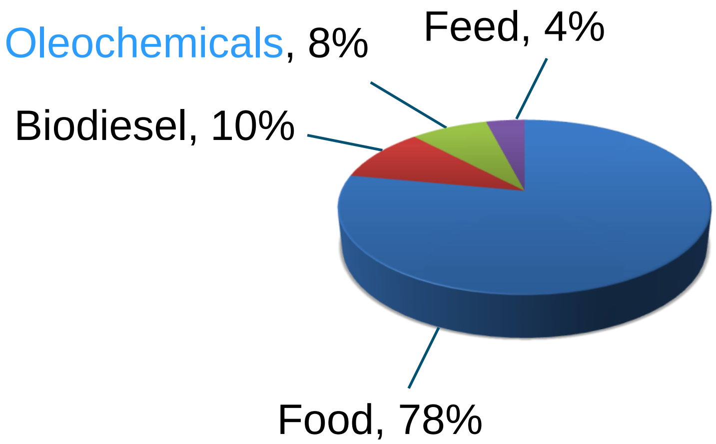
Introduction to vegetable oils



Source(s): US Department of Agriculture; USDA Foreign Agricultural Service; ID 263933

Introduction to vegetable oils

- Majority of oils and fats used for food



Source: Oil World, ISTA Mielke GmbH

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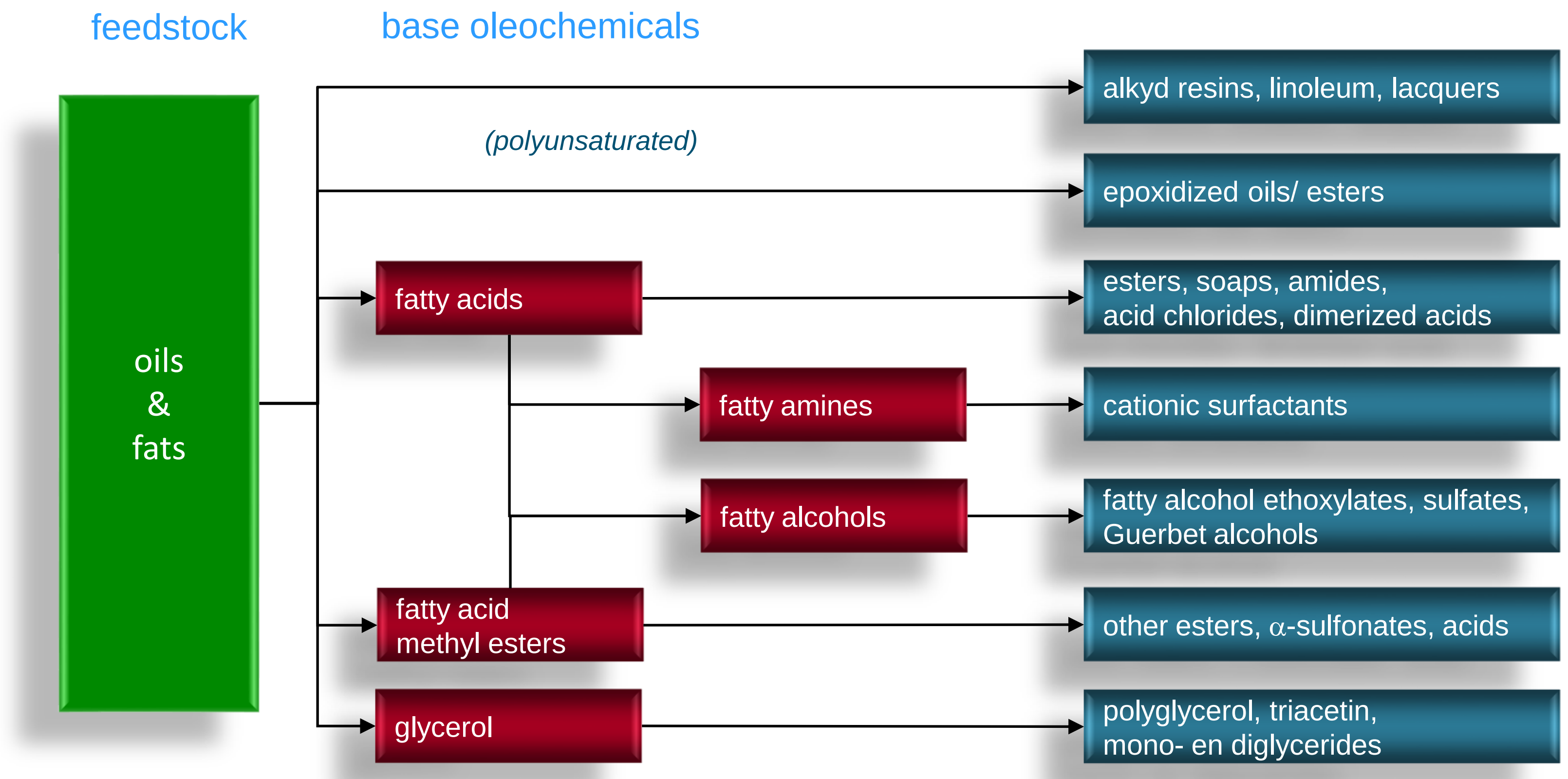
Oleochemicals production



Applications of oleochemicals

- Soaps and detergents (>50%)
- Plastic and rubber additives
- Coatings, inks and adhesives
- Personal care
- Pharma
- Paper chemicals

- Lubricants
- Candles
- Solvents
- Oilfield chemicals
- Linoleum

….and many others



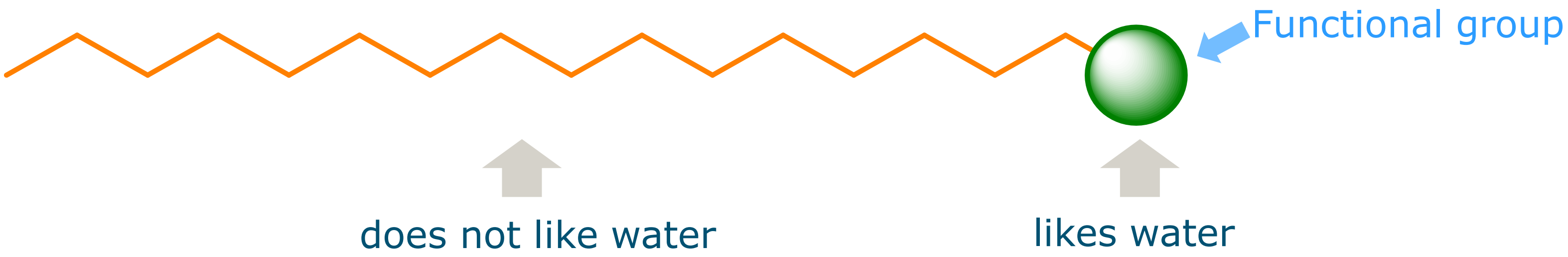




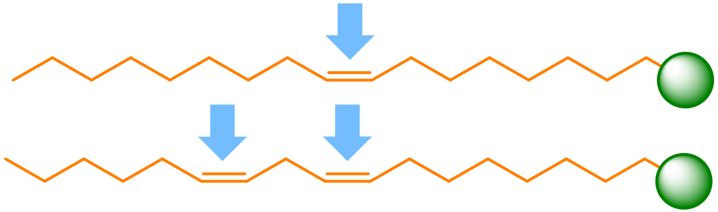



Applications of oleochemicals

- Predominantly as *monofunctional* fatty acid derivatives



- For oleochemical **materials**, *polyfunctionality* is required
  - usually involves the C=C bonds of (poly)unsaturated FAs



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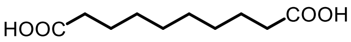
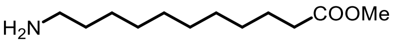
Oleochemicals as feedstock for materials

- *Bifunctional* oleochemicals are highly desired for polymer applications
  - *dimer fatty acids* and derivatives (*e.g*. polyester diols)
  - *azelaic acid* from oleic acid by ozonolysis
  - *methyl 11-aminoundecanoate* from castor oil
  - *sebacic acid* from castor oil

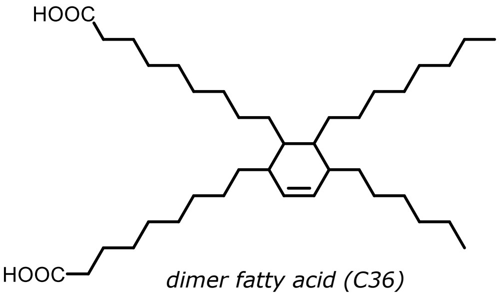
azelaic acid (C9)



sebacic acid (C10)



methyl 11-aminoundecanoate (C11)



dimer fatty acid (C36)

Flexibility and elasticity
Water and chemical resistance

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Oleochemicals as feedstock for materials

- Two examples of WFBR projects
  - paints from 100% bio-based alkyd resins

  - isocyanate- and epoxy-free rail fastening elastomers

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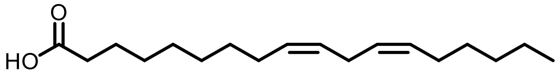
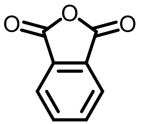
Bio-based alkyd resins

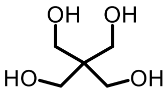
- Typical alkyd resin: petrochemical polyester backbone with (polyunsaturated) fatty acid side chains



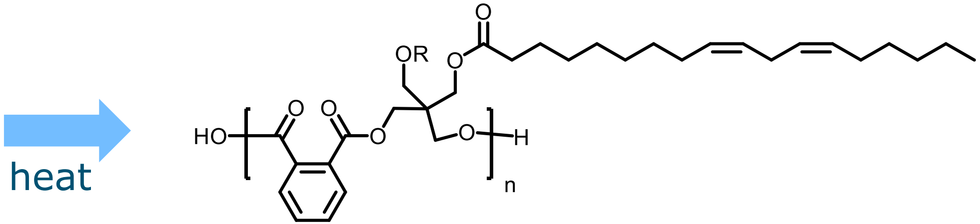
FA from e.g. soybean, safflower or sunflower oil, TOFA



phthalic anhydride

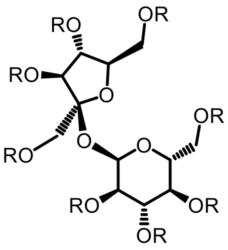


pentaerythritol



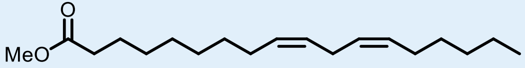
- Challenge: bio-based backbone without compromising performance

100% bio-based HS alkyds derived from sucrose

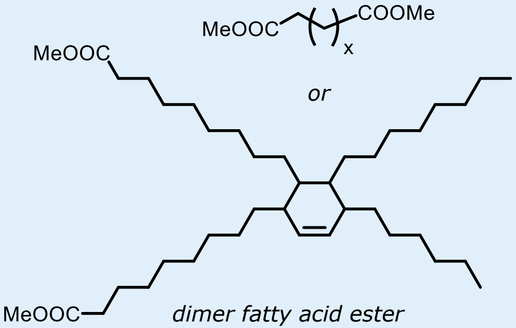


sucrose
or
sucrose acetates

all vegetable oil-derived

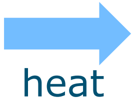


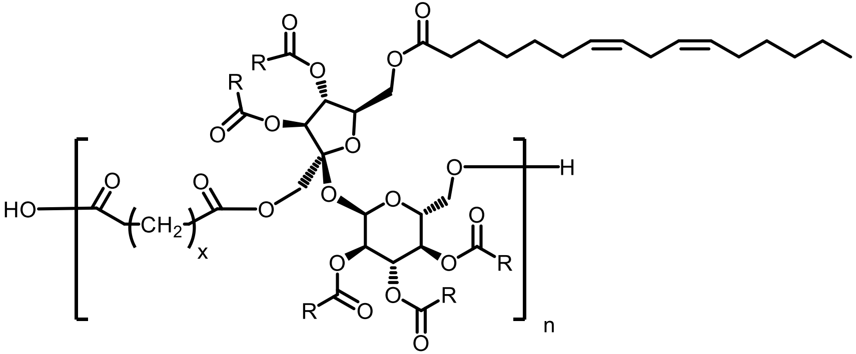
FAME



or

dimer fatty acid ester





100% bio-based HS alkyds derived from sucrose

Main conclusions:

- Low VOC-values 80 - 270 g/l
- Fast (through) drying
- Good initial whiteness
- Hard, flexible films
- Levelling is very good (due to high solids content)
- Good gloss retention in QUV-A
- High shear viscosity

E.A. Oostveen, J.G.J. Weijnen, J. van Haveren, M. Gillard,
Air drying paint compositions comprising carbohydrate based polyesters,
WO 03064498

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Isocyanate-/epoxy-free rail fastening elastomers

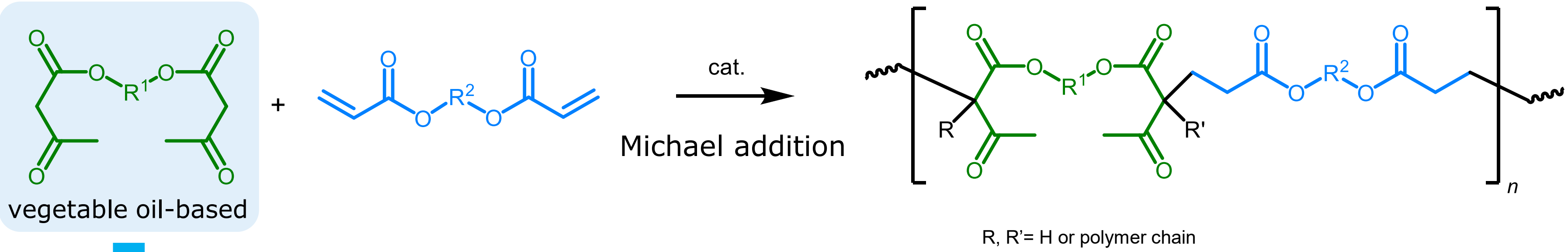
- Current 2K resin based on isocyanates
- Oleochemical alternative:
  - Component A: 80% bio-based
    Component B: not (yet) bio-based
  - Same fast curing speed (30 min.) at RT
  - Good strength and elasticity
  - Excellent water and electrical resistance
  - Label-friendly product

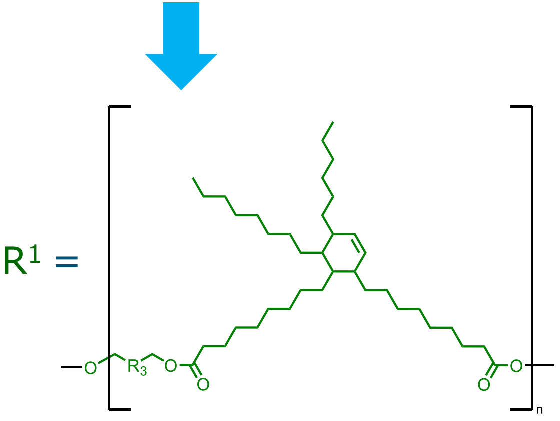
Tram rail model with new resin

CRODA

edilon)(sedra

Isocyanate-/epoxy-free rail fastening elastomers





- Polymer properties determined by:
  - structure of R^1 and R^2
  - number of Michael donor (e.g. acetoacetate) and acceptor (e.g. acrylate) groups attached to R^1 and R^2
  - ratio of Michael donor and acceptor groups in resin

Concluding remarks

- *Oleochemicals* offer unique material performance, such as flexibility and water resistance
- More efficient and selective technologies to convert oils and fats to *bifunctional monomers* could open up new markets for oleochemical materials

Thank you

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