BIOMASSA TRIGLISERIDA:

*ILMU KIMIA, POTENSI, PEMANFAATANNYA UNTUK PANGAN, ENERGI, DAN KESEHATAN dan IMPLIKASINYA PADA PEMBELAJARAN KIMIA **

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ABSTRAK

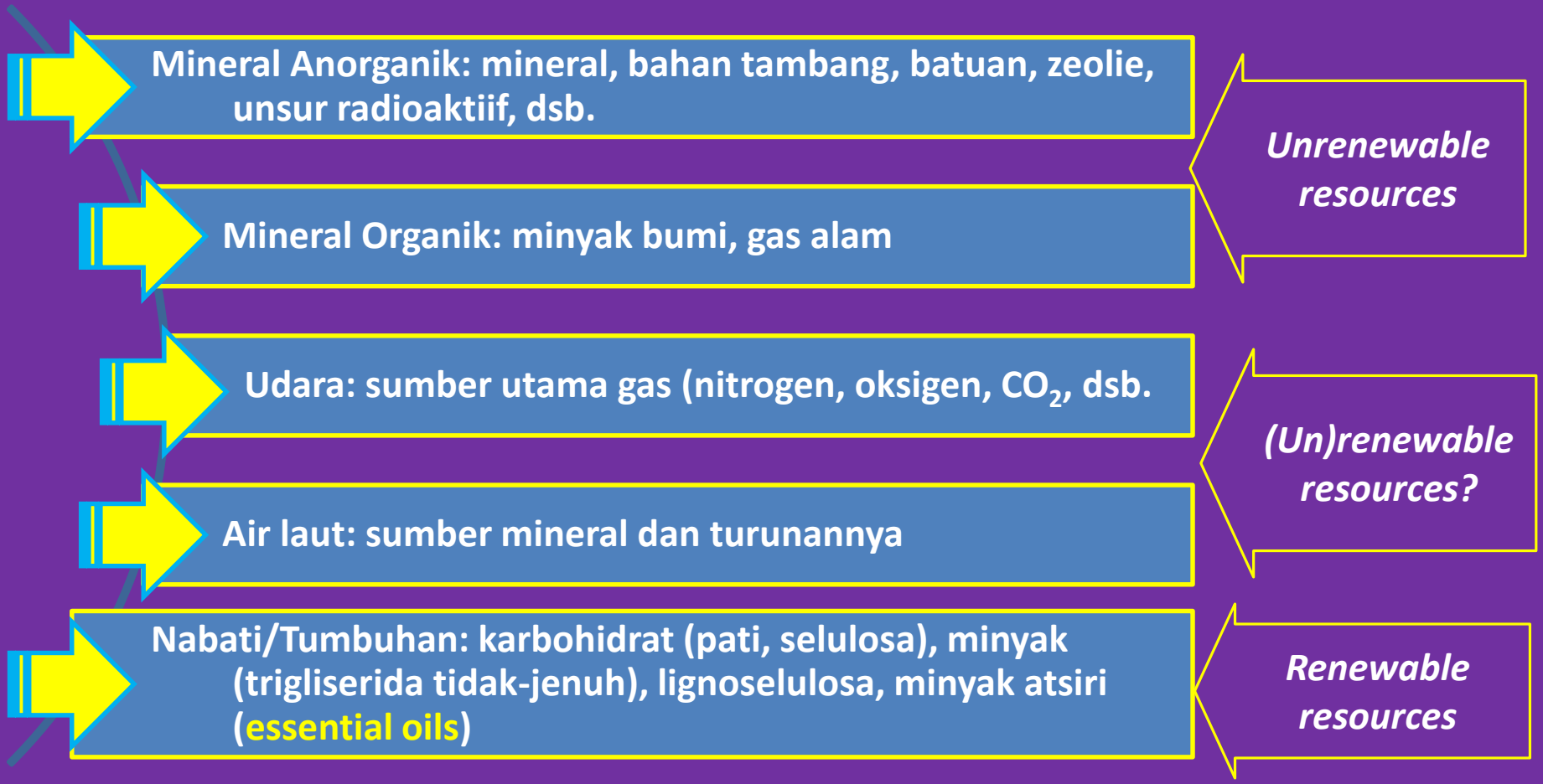
Secara umum, bahan kimia (*chemicals*) dimanfaatkan untuk pangan-sandang-papan-energi-obat & kosmetika-*daily life utility*. Bahan kimia tersebut dibangun dari sumberdaya alam, baik renewable (pati, selulosa, lignin, lignoselulosa, dan trigliserida), unrenewable resources (mineral anorganik, mineral organik-minyak bumi, dan gas alam), maupun udara & air. Minyak (nabati & ikan) sebagai *trigliserida tidak-jenuh*, khususnya minyak nabati (edible dan non-edible oils) merupakan salah sumberdaya alam yang di Indonesia cukup melimpah dan relatif mudah dibudidayakan. Derivatisasi minyak nabati melalui konversi & transformasi dengan potensi sebagai bahan kimia untuk energi (energy chemicals): FAME & FAEE, sol ketal, hidrokarbonl, dan produk cracking catalytic dan pangan & obat-obatan (food & drug chemicals): sabun (K, Al, Zn), FFA, FAME, monogliserida, dan laktonnya menjadi fokus riset dan karya tulis ini.

Kata-kunci: minyak nabati, sabun-K, Al, dan Zn, FFA, FAME-FAEE, sol ketal, monogliserida

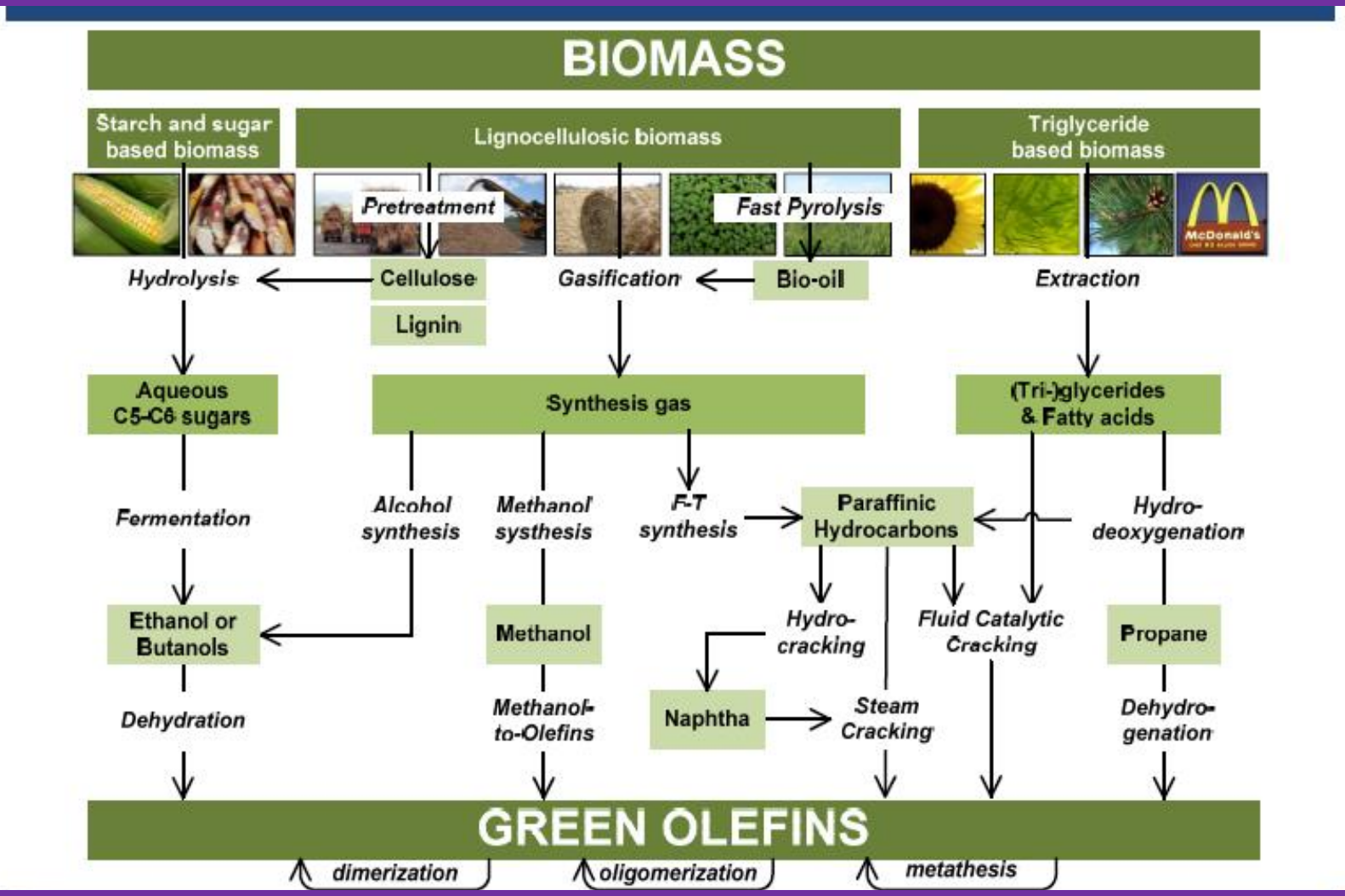
PEMANFAATAN BAHAN KIMIA (UNTUK KEHIDUPAN)

1. Bahan Kimia untuk Pangan *(Chemicals for Food and Feed)*
2. Bahan Kimia untuk Sandang (*Chemicals for Textile*)
3. Bahan Kimia untuk Papan (*Chemicals for Materials Building*)
4. Bahan Kimia untuk Energi (*Chemicals for Energy*)
5. Bahan Kimia untuk Obat(an) dan Kosmetika (*Chemicals for Drugs & Cosmetics*)
6. Bahan Kimia untuk Keseharian (*Chemicals for Daily Life*)

SUMBERDAYA ALAM SEBAGAI *CHEMICALS FEEDSTOCKS*



BAHAN KIMIA GREEN (GREEN CHEMICALS)



BAHAN BAKU GREEN (GREEN FEEDSTOCKS)

Biomass to Fuels and Olefins

Triglyceride and Fatty Acid based Biomass

Hydrodeoxygenation

CO, CO_2, H_2O

Hydrocarbon Liquids

Hydro-Cracking

Fluid Cat. Cracking

Steam Cracking

Green Fuels

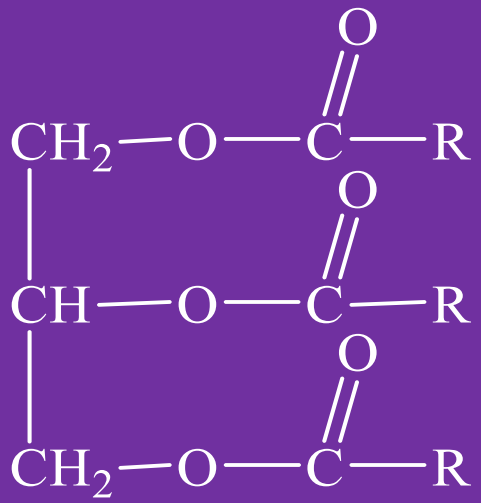
Green Olefins

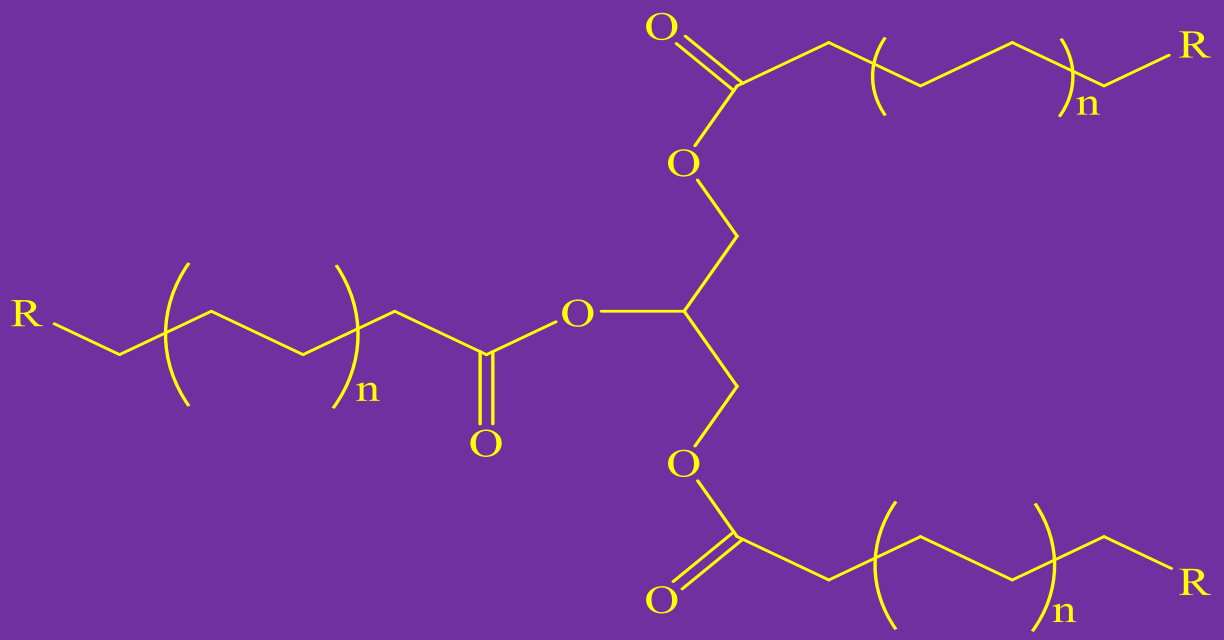
BIOMASSA TRIGLISERIDA: what is it?

- Trigliserida: ester dari gliserol (1,2,3-propana triol) dengan asam lemak (*fatty acids*), R---COOH
- Jika gugus asil (R---CO-) pada R---COOH mengandung ikatan ganda C=C (mono atau poli), disebut sebagai TRIGLISERIDA TIDAK-JENUH dan merupakan minyak (OILS)
- Minyak (trigliserida tidak-jenuh) merupakan metabolit (sekunder/primer) yang banyak dihasilkan oleh tumbuhan
- Bagian organ tanaman sebagai penghasil minyak (pada umumnya) adalah BIJI.

BIOMASSA TRIGLISERIDA: what is it?

- ***Struktur Umum:***





- Untuk R (dengan ikatan ganda C=C): minyak (oils)
- Untuk R (tanpa ikatan ganda C=C): lemak (fat)
- Keragaman R- dan n menentukan sifat trigliserida (lemak atau minyak)

TRIGLISERIDA TIDAK JENUH = MINYAK

- ASAM LEMAK YANG TERKANDUNG BERAGAM, IKATAN GANDA C=C MONO ATAU POLI, & pada beberapa MINYAK mengandung gugus OH
- DIBEDAKAN:
  - Asam lemak jenuh (*saturated fatty acids*), *SFA*
  - Asam lemak tidak-jenuh (*unsaturated fatty acids*), *UFA*
  - UFA dibedakan menjadi *mono unsaturated fatty acids* (MUFA) dan *poly unsaturated fatty acids* (PUFA)
- Ragam R menentukan sifat asam lemak (*FA, fatty acids*) → minyaknya
- Rekayasa kimia berbasis asam lemak merupakan dasar dari minyak sebagai ***renewable feedstocks***

KLASIFIKASI ASAM LEMAK BERDASAR PANJANG RANTAI C-ASIL

Sumber: Nabati

Asam lemak rantai pendek (SCFA)

- C5 – C8
- UMUMNYA JENUS

Asam lemak rantai medium (MCFA)

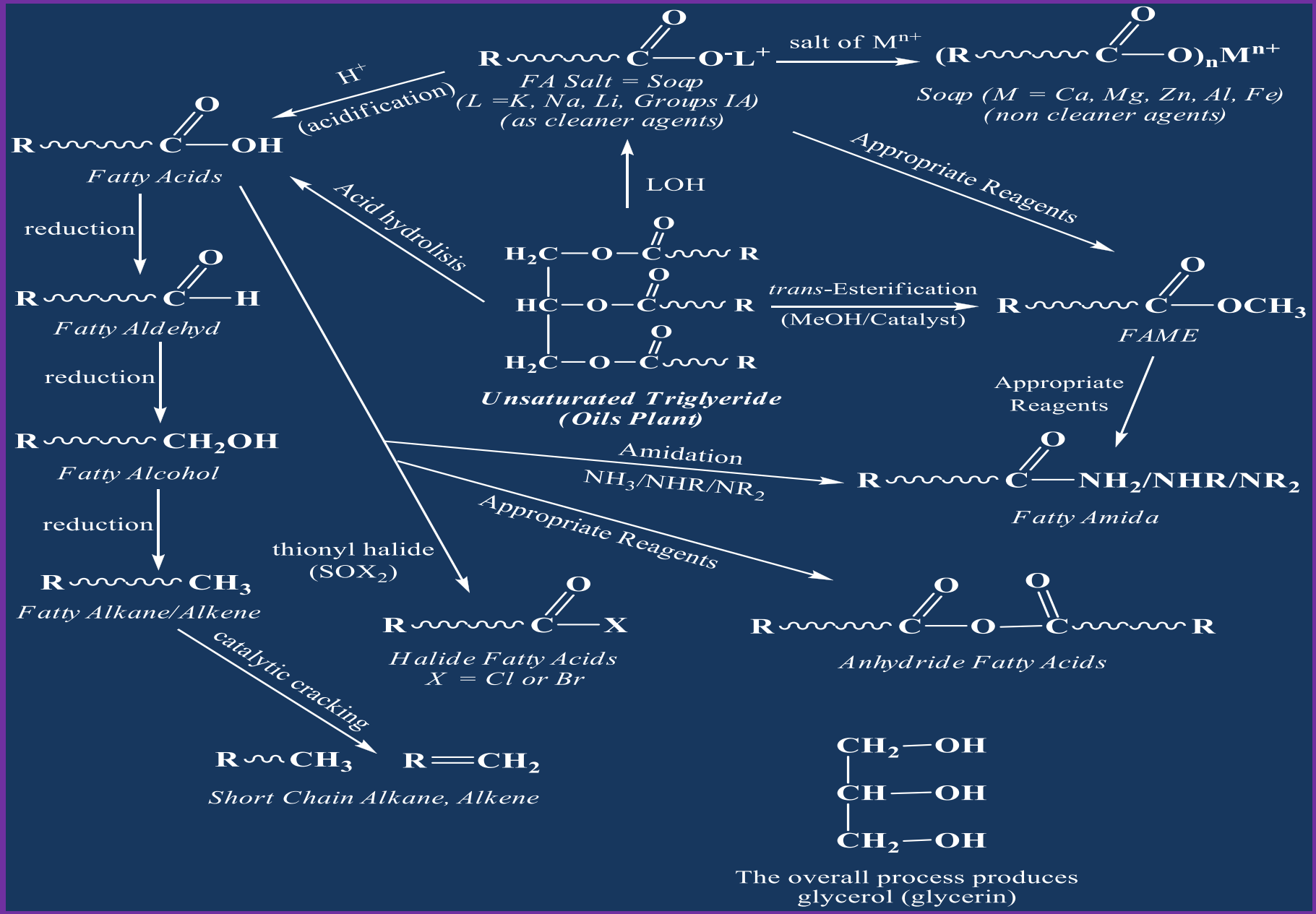
- C8 – C14
- UMUMNYA JENUH

Sumber: Ikan

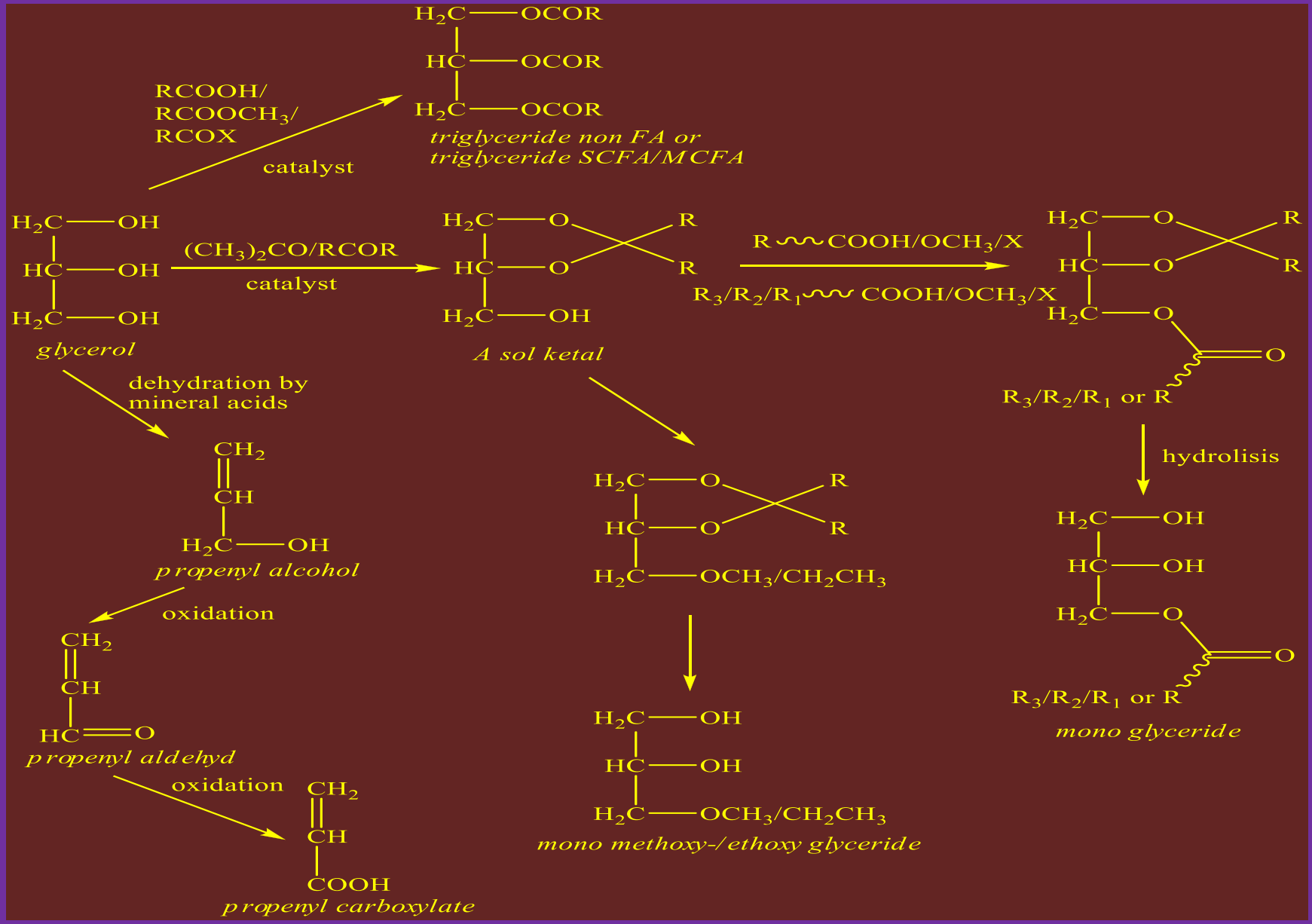
Asam lemak rantai panjang (LCA)

- C16 – C24
- JENUH dan TIDAK JENUH

DERIVATISASI BERBASIS MINYAK NABATI



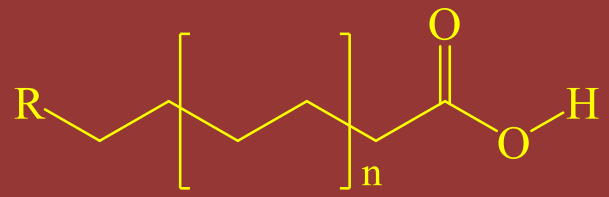
DERIVATISASI GLISEROL Berbasis Minyak Nabati



FA or FFA: (Free) Fatty Acids

FA or FFA: fatty acids or free fatty acids (saponification → acidification), or acids hydrolysis

FA (FFA): SCFA, MCFA, and LCFA, & MUFA and PUFA



n = MCFA, LCFA, saturated, & unsaturated

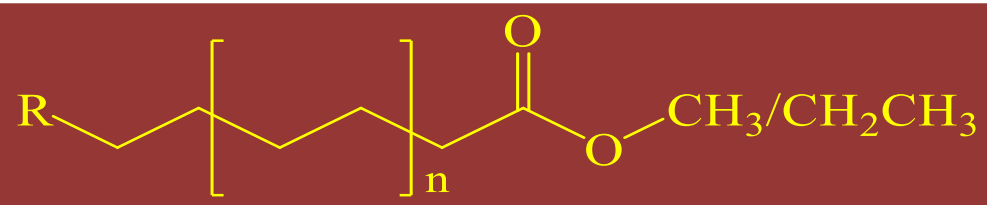
Biodiesel, as ***fuel: LCFA nabati***

Antibakterial, antimicrobial: ***antibiotics: MCFA, LCFA (MUFA & PUFA)***

FAAE: Fatty Acids Alkyl Ester

FAME: fatty acids methyl ester (by trans-esterifikation with MeOH, many catalyst)

FAME: fatty acids ethyl ester (by trans-esterifikation with EtOH, many catalyst)



n = MCFA, LCFA, saturated, & unsaturated

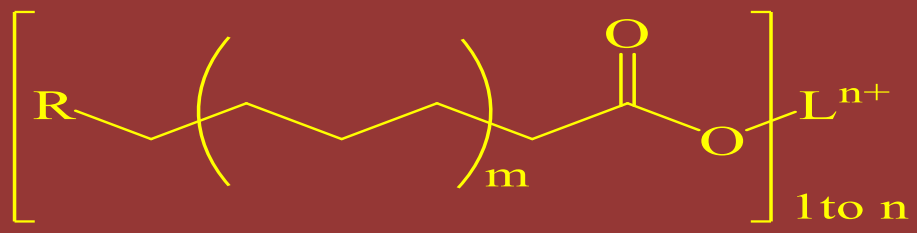
Biodiesel, as ***fuel: LCFA nabati***

Antibakterial, antimicrobial: ***antibiotics: MCFA, LCFA (MUFA & PUFA)***

FAS: Fatty Acids Salts

Na-, K-Soap: hard – and soft soap (saponification with NaOH or KOH):

Al-, Zn-Soap: n is variety (saponiification by Na or KOH, and trans-saponifation with Al or Zn salt)



m = MCFA, LCFA, saturated, & unsaturated, L = Na, K, Al, Zn

Emulsifier, chemicals cleaner, Antibakterial, antimicrobial: ***MCFA, LCFA: mufa & pufa***

Lubricant additives, potensi lainnya: ***LCFA (MUFA & PUFA)***

MG: MONOGLYCERIDES

Surfaktan, biasanya dalam bentuk pengemulsi

Bersama digliserida, monogliserida biasanya ditambahkan ke produk makanan komersial dalam jumlah kecil sebagai (s.a. Mono dan digliserida dari asam lemak), mencegah pemisahan minyak dan air.

MANFAAT

Nilai-nilai dalam label nutrisi untuk total lemak, lemak jenuh, dan lemak trans tidak termasuk yang ada dalam mono dan digliserida karena lemak didefinisikan sebagai trigliserida

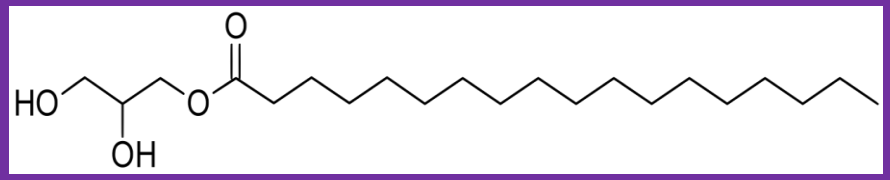
Monogliserida digunakan untuk meningkatkan stabilitas fisik terhadap creaming dalam minuman susu.

Dalam produk roti, minuman, es krim, permen karet, shortening, topping kocok, margarin, dan permen untuk meningkatkan volume dan tekstur roti, dan sebagai agen antistaling

dari FAME ke AAFE

FAME

AAFE



Glyceryl monostearate

- cosmetic
- *food additives*

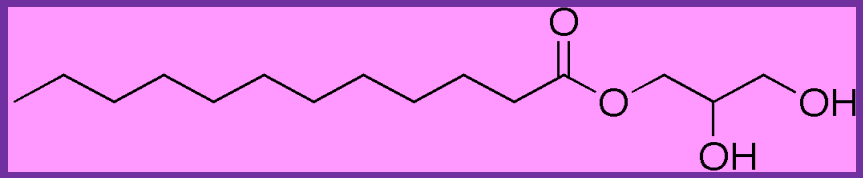
Monolaurin

Mono stearin

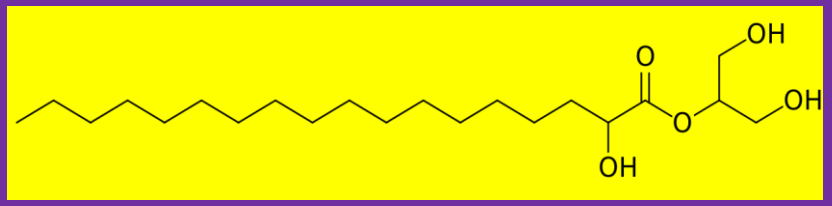
- in foods as a thickening, emulsifying, and preservative agent

- cosmetic
- skin care products

Mono hidroksi stearin



Monolaurin



Glyceryl hydroxystearate

Our research: past, present, and future on Triglyceride Oils

1. Isolation, Characterization, & Identification of fish oils ()
2. Synthesis of Al- & Zn-Soap, and its potential development:
3. Synthesis FAME and FAEE and its potential as biodiesel
4. Maping the content of fatty acids in vegetable oils and their derivatization (*K-Soap, FAME, monoglyceride, and olefine*), and their potential as an *antimicrobial* and *bio-fuel*
5. Cyclization of acyl with COOH → lactone

Fuel (Energy) chemicals

Non Fuel (Food, Drug, etc) Chemicals

Produk reduksi total dan/atau cracking catalyitic

Produk reduksi FA (Fatty alcohol, fatty aldehyde)

Mono- and Di-glycerides

Sol ketal

Cyclization of acyl with COOH → ***lactone***

FAME dan FAEE

(Free) Fatty Acids (FFA)

FA-Salts = SOAP (Na-, K-, Al-, Zn-soap)

Isolasi, identifi
karakterisasi

Vegetable oil research

sunflower oil

sesame oil

corn oil

candlenut oil

virgin coconut oil

castor (*R. communis* oil)

Jatropha curcas oil

neem *(mimba)* oil

olive oil

black sed oil

soybean oil

peanut oil

HASIL DAN PENGEMBANGAN

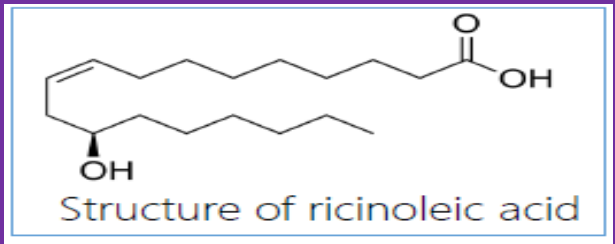
- Asam lemak: asam stearat, asam oleat
- Minyak nabati: kelapa, sawit, mimba, jarak pagar, jarak kepyar, kemiri, asam jawa, jagung, wijen, bunga-matahari, VCO, zaitun, kedelai, habbatus (jinten), dan kacang tanah
- Secara umum kandungan asam lemaknya identik: C_{16} (oleat & linoleat, risinoleat) dan C_{18} (linolenat), kecuali VCO (laurat, C_{12})
- *Minyak ikan: ikan salmon, ikan lemuru, ikan hiu, ikan tengiri (dengan kandungan asam-asam lemak: linoleat, linolenat, EPA, DHA) (s.d. 2004)*

HASIL DAN PENGEMBANGAN

- **Derivatisasi minyak nabati sebagai sabun:**
  - Sabun aluminium (PO, CPO, & jarak: kepyar & pagar, mimba, kemiri dengan Al-sulfat dan Al-klorida) (sebagai aditif lubricant)
  - Sabun zink (PO, CPO, & jarak: kepyar & pagar, mimba, kemiri dengan Zn-sulfat dan Zn-klorida)
  - Sabun kalium (K-soap) (wijen, kemiri, jagung, bunga matahari, jarak kepyar, dan VCO) (sebagai agen antibakteri non triklosan)
- **Derivatisasi minyak nabati menjadi asam-asam lemak bebas (FFA)nya:**
  - Asam-asam lemak penyusun dalam bentuk campurannya (FFAnya) dan (PO, CPO, & jarak: kepyar & pagar, mimba, wijen, kemiri, jagung, bunga matahari, VCO) → sebagai agen antibakteri.

HASIL DAN PENGEMBANGAN

- **Derivatisasi minyak nabati sebagai alkil esternya:**
  - FAME dan FAEE (PO, CPO, & jarak: kepyar & pagar, mimba, kemiri) → sebagai biodiesel
  - FAME (wijen, kemiri, jagung, bunga matahari, jarak kepyar, dan VCO) → sebagai agen antibakteri
- **Derivatisasi minyak nabati sebagai Sol ketal dan Monogliseridanya:**
  - Sol ketal (wijen, kemiri, jagung, bunga matahari, jarak kepyar, dan VCO) → sebagai bahan bakar alternatif
  - Monogliserida (wijen, kemiri, jagung, bunga matahari, jarak kepyar, dan VCO) → sebagai agen antibakteri dan food preservative.



Structure of ricinoleic acid

Kandungan asam lemak dalam beberapa minyak nabati

Asam lemak (%)	Minyak						
	Jatropha	Castor	Bunga matahari	Wijen	Kemiri	Jagung	VCO
Laurat (12:0)							50
Miristat (14:0)							20
Palmitat (16:0)	14		2	6	3	2	10
Stearat (18:0)	7		39	43	43	36	
Oleat (18:1, cis-9)	45	6	9	10	7	14	10
Linoleat (18:2, cis-9,12)	**33**	**7**	**50**	**42**	**48**	**49**	
Risinolenat (18:1, cis-9)		85					
Total UFA (mufa & pufa)	78	98	59	52	55	63	10

AKTIVITAS ANTI-BAKTERI (*E. coli & S. aureus*)

Derivat	Kons. (%)	Bakteri	Aktivitas antibakteri (*diameter zona hambat*, mm)					
			Jarak kepyar	Bunga matahari	Wijen	Kemiri	Jagung	VCO
K-soap	1	*E. coli (-)*	**18,8**	6,9	7,6	7,9	8,7	**8,9**
	2		**18,9**	7,4	10,2	9,4	14	**10**
	1	*S. Aureus (+)*	**14,7**	8,3	7,9	7,6	7,8	**10,9**
	2		**16,9**	10,1	10,9	11,0	11,1	**11,5**
(F)FA	1	*E. coli (-)*	**15,8**	6,2	6,8	9,5	9,0	**11,0**
	2		**17,5**	8,0	10,1	9,9	10,1	**12,3**
	1	*S. Aureus (+)*	**13,3**	7,0	7,1	7,7	8,3	**10,4**
	2		**16,4**	8,5	10,2	8,9	9,2	**14,2**
FAME	1	*E. coli (-)*	--	--	--	6,8	6,8	--
	2		**8,2**	6,8	6,7	7,4	8,2	**7,8**
	1	*S. Aureus (+)*	--	--	--	--	6,7	--
	2		**8,8**	6,1	6,9	6,5	7,8	**8,9**
UFA total (MUFA & PUFA			**98**	**59**	**52**	**55**	**63**	**10**

IMPLIKASINYA PADA PEMBELAJARAN KIMIA (di Sekolah & PT)

- Kontekstualisasi hasil-hasil riset berbasis minyak (*plant oil & fish oil*)
- ***Inquiry-based Learning*** sebagai **Pendekatan Belajar** dengan ragam **Strategi** dan/atau **Modelnya** dengan berbasis pada data-data hasil riset
- Membangun kreasi (berkreasi) dan berinovasi untuk pemberdayaan potensi minyak, baik nabati maupun ikan, edible and/or non-edible oil

KESIMPULAN

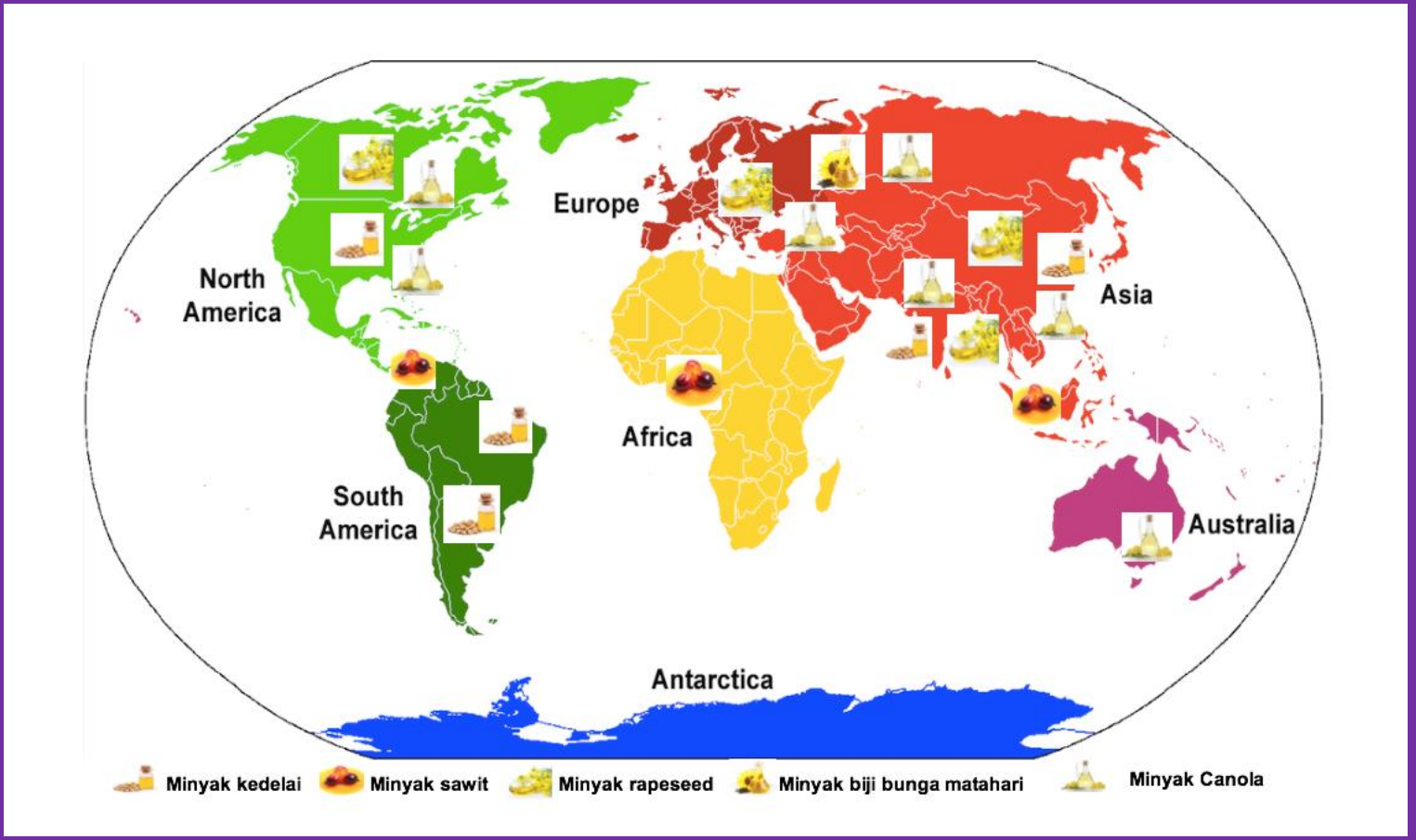
1. Secara umum minyak nabati mengandung asam lemak tidak jenuh, kecuali VCO (ini merupakan hasil olah khusus minyak coconut). SFA dalam VCO merupakan MCFA
2. Kandungan asam lemak tidak-jenuh (UFA) lebih dari 50%, kecuali VCO
3. Makin banyak kandungan UFA makin tinggi aktivitas antibakterinya
4. Makin polar senyawa makin tinggi aktivitas antibakterinya
5. Derivat minyak (castor, wijen, kemiri, jagung, bunga-matahari, dan VCO) berpotensi sebagai ANTIBIOTIK, dengan potensi antibakteri terhadap Gram-Positif lebih kuat dibanding pada Gram-Negatif (kecuali untuk castor oil)

AKNOWLEDGMENT

Ucapan terimakasih yang tak terhingga disampaikan kepada:

1. Pimpinan FMIPA (Dekan), Pimpinan Jurusan Kimia (Ketua Jurusan), dan Panitia SNKP-2019 (Ketua) atas kepercayaannya kepada pemakalah sebagai KEYNOTE SPEAKER pada SNKP-2019
2. Rektor UM atas dukungan pendanaan riset melalui Dana PNBP 2019 dan sebelumnya atau sesudahnya

terimakasih



Nama	Sumber	Kandungan asam lemak utamanya	UFA
Minyak ikan lemuru (*Sardinella longiceps*)	2,17% (lemuru basah) atau 11,96% (lemuru kering)	Palmitoleat (12,06%), miristat (12,43%), stearat (14,4%), oleat (15,37%), palmitat (31,64%), EPA (1,28%)	
Minyak ikan tengiri (*Scomberomorus lineatus*)	7,53% (basah) atau 3,73% (kering)	Palmitat (40,13%), miristat (4,61%), palmitoleat/ 9-heksadekenoat (10,22%), stearat (19,07%), vaksenat/ 11-oktadekenoat (9,75%), EPA (7,88%)	
Minyak ikan tuna (*Tunnus maccoyii*)	2,18% (berat basah)	Palmitat (40,07%), arakidonat/ (4,61%), palmitoleat/ 9-heksadekenoat (10,22%), stearat (14,60), vaksenat/ cis-11-oktadekenoat (16,49%), EPA (2,00%)	
Minyak hiu			

EPA = 5,8,11,14,17-eicosapentaenoic acid
Arachidonic acid = 5,8,11,14-eicosatetraenoic acid

Kadar asam lemak jenuh dan tidak jenuh dalam minyak gliserida hati ikan hiu penumbuk *(Alopias vulpinus)*

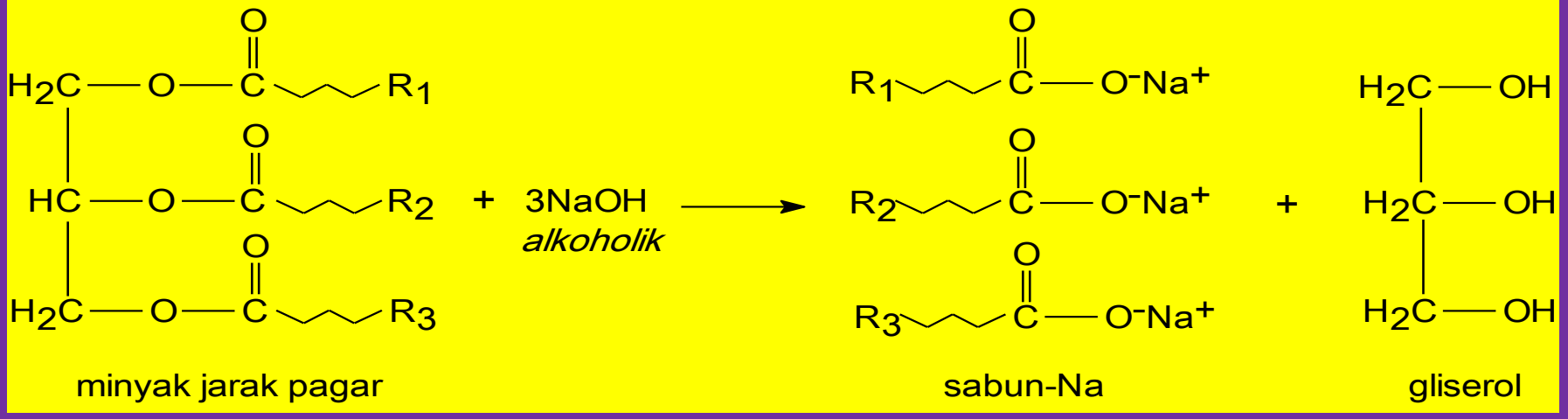
Asam Lemak	Minyak Hasil Penjemuran (%)	Minyak Hasil Ekstraksi Pelarut (%)
Jenuh		
Asam tetradekanoat (asam miristat)	3.34	**3.84**
Asam heksadekanoat (asam palmitat)	18.83	**25.21**
Asam heptadekanoat	2.67	**7.13**
Asam oktadekanoat (asam stearat)	8.77	**9.32**
	Σ = 33.61	**Σ = 45.50**
Tidak Jenuh		
Asam 9-heksadekenoat	7.09	**7.89**
Asam 7-oktadekenoat	13.01	**-**
Asam 9-oktadekenoat	-	**6.57**
EPA	4.83	**4.25**
DHA (docosa hexaenoic acid)	15.11	**6.36**
Asam dokosenoat	2.30	**-**
	Σ = 42.34	**Σ = 25.07**

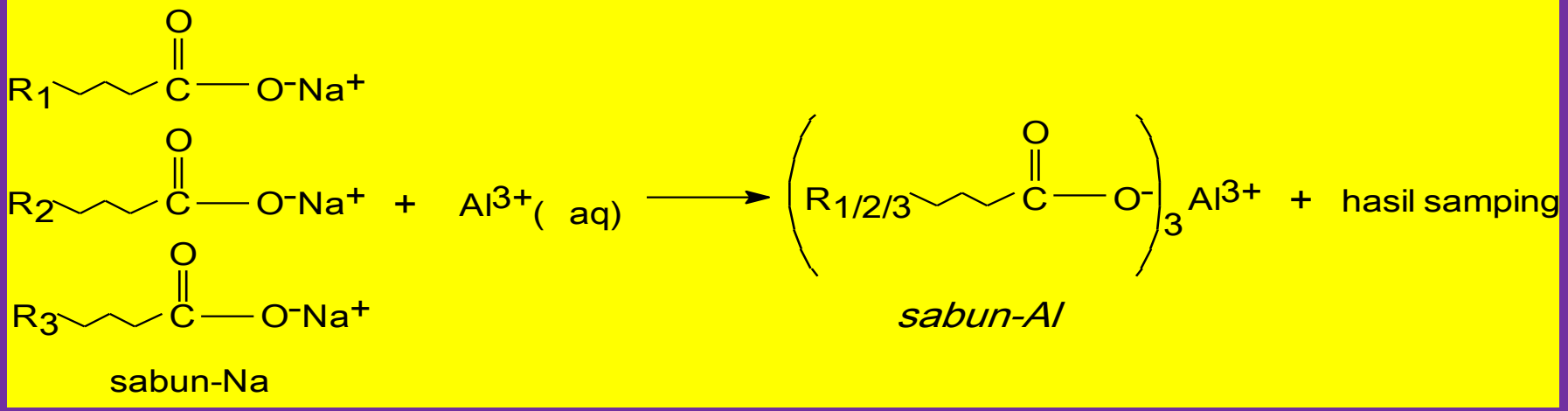
*Disampaikan pada **Simposium Nasional Kimia Bahan Alam XIV** di Bandung, 16–17 Desember 2004*

Minyak mimba (Neem)

Komponen senyawa penyusun metil ester minyak biji mimba (*Azadirachta Indica A Juss)* berdasarkan hasil identifikasi menggunakan instrumen GC-MS adalah metil palmitoleat, metil palmitat, metil margarat, metil oleat, metil stearat, dan metil arakhidonat (2010)

Sumber Asam Lemak	Sumber Aluminium	Sifat			Sumber Rujukan
		Wujud	Kelarutan	Titik Lebur (°C)	
Asam Stearat	$Al_2(SO_4)_3$	Serbuk putih	Sedikit larut dalam benzena dan petroleum eter	142-150	**Sa'adah (2004)**
	$AlCl_3$	Serbuk putih	Sedikit larut dalam kloroform	± 180 (dekomposisi)	**Kasiyati (2004)**
Asam Oleat	$Al_2(SO_4)_3$	Serbuk putih kekuningan	Sedikit larut dalam kloroform	± 120 (dekomposisi)	**Rahmawati (2004)**
	$AlCl_3$	Serbuk putih kekuningan	Larut dalam kloroform	± 150 (dekomposisi)	**Pangestu (2004)**
Minyak Sawit	$Al_2(SO_4)_3$	Serbuk putih	Larut dalam kloroform	104-194	**Nuriami (2008)**
	$AlCl_3$	Serbuk putih	Larut dalam kloroform	115-205	**Rosita (2005)**
	$AlCl_3$	Serbuk putih	Larut dalam kloroform	195-233	**Pranna (2008)**
Minyak Sawit Curah	$Al_2(SO_4)_3$	Serbuk putih	Larut dalam kloroform	180-218	**Dewi (2008)**
	$AlCl_3$	Serbuk putih	Larut dalam kloroform	203-231	**Kartikasari (2008)**
Minyak Jarak Kepyar	$Al_2(SO_4)_3$	Serbuk putih	Larut dalam kloroform	± 220 (dekomposisi)	**Millah (2008)**
	$AlCl_3$	Serbuk putih	Larut dalam kloroform	200-340 (dekomposisi)	**Assaiddah (2008)**
Minyak Jarak Pagar	$Al_2(SO_4)_3$	Serbuk putih kekuningan	Larut dalam kloroform	264-322	**Novita (2008)**
	$AlCl_3$	**Serbuk putih**	**Larut dalam kloroform**	**205-221**	**Fatmawati (2008)**


H2C — O — C — R1
HC — O — C — R2
H2C — O — C — R3
O
+ 3NaOH
alkoholik
R1 — C — O-Na+
R2 — C — O-Na+
R3 — C — O-Na+
+
H2C — OH
H2C — OH
H2C — OH
minyak jarak pagar
sabun-Na
gliserol


R1 — C — O-Na+
R2 — C — O-Na+
R3 — C — O-Na+
O
+ Al3+(aq)
R1/2/3 — C — O-
3
Al3+
+ hasil samping
sabun-Na
sabun-Al

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POSTER

Synthesis and Characterization of Zinc-Soap Based-on Crude Palm Oil

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Abstract

Zinc stearate (Zn-stearate) and zinc oleate (Zn-oleate) have been synthesized, characterized, and identified from stearic acid and oleic acid and these compounds were called zinc-soap. In the other hand, Al-soap (Al-stearate, Al-oleate, Al-fatty acid from palm oil, and Jathropha curcas oil) have also been synthesized, characterized, and identified. Palm oil is known as a source of fatty acids, and from its saponification reaction by sodium or potassium hydroxide sodium- or potassium soap was obtained. This is known industrially and commercially. Based on the successful result of both Zn-soaps (Zn-stearat and Zn-oleate and Al-soaps and commercially synthesized sodium- or potassium soaps, the synthesis of zinc soap based-on palm oil was carried out. The research was done since palm oil is potentially developed and the diversification products are in the frame of sustainable chemistry in Indonesia and in the world. The research consists of three steps, including (1) saponification reaction of crude palm oil by sodium hydroxide to obtain sodium soap (Na-soap), (2) synthesis of zinc soap (Zn-soap) by trans-saponification of Na-soap with zinc salts, and (3) characterization and identification of Zn-soap. Zinc sulfate and Zinc chloride have been used in the research as the source of aluminum. Aluminum soap can be synthesized from crude palm oil and alcoholic sodium hydroxide by saponification reaction and then reaction of Na-soap and zinc ion by trans-saponification. The physical properties of Zn-soap are yellowis-white powder, m.p. 83–93°C (with Zn-sulfate) and 87–95°C (with Zn-chloride), highly soluble in benzene and vernis, slightly soluble in chloroform, and insoluble in water, ethanol, octanol, petroleum ether, and n-hexane and acetone.

***Keywords**: crude palm oil, trans-saponification, Zn-soap.*

IOP Conf. Series: Earth and Environmental Science **299** (2019) 012004 doi:10.1088/1755-1315/299/1/012004

Study of antibacterial activity of *Tamarindus indica* Linn seed oil and its fatty acids

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Abstract. The study of antibacterial activity of oil from *Tamarindus indica* Linn seed and fatty acids was conducted in this research. Oil of this plant seed was isolated by extraction and fractionation. Constituents of fatty acid in the oil identified as methyl ester fatty acids. The methyl ester fatty acid was carried out by trans-esterification with methanol/BF_3. The methyl ester was identified by gas chromatography and mass spectrometer (GC-MS). There are 13 fatty acids in the *Tamarindus indica* seed oil including octanoic, decanoic, dodecanoic, tetradecanoic, hexadecanoic, octadecanoic, eicosanoic, docosanoic, tetracosanoic, 11-octadecenoic, 11-eicosenoic, 9,12-octadecadienoic, and 9-octadecenoic acids. The transformation of tamarind seed oil into fatty acids was carried out through hydrolysis with potassium hydroxide solution followed by acidification with a hydrochloric acid solution. The physical and biological properties of the seed oil and fatty acids against antibacterial activity are reported in this paper.

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Fatty Acids in *Tamarindus indica* L. Seeds Oil and Antibacterial Activity Assay

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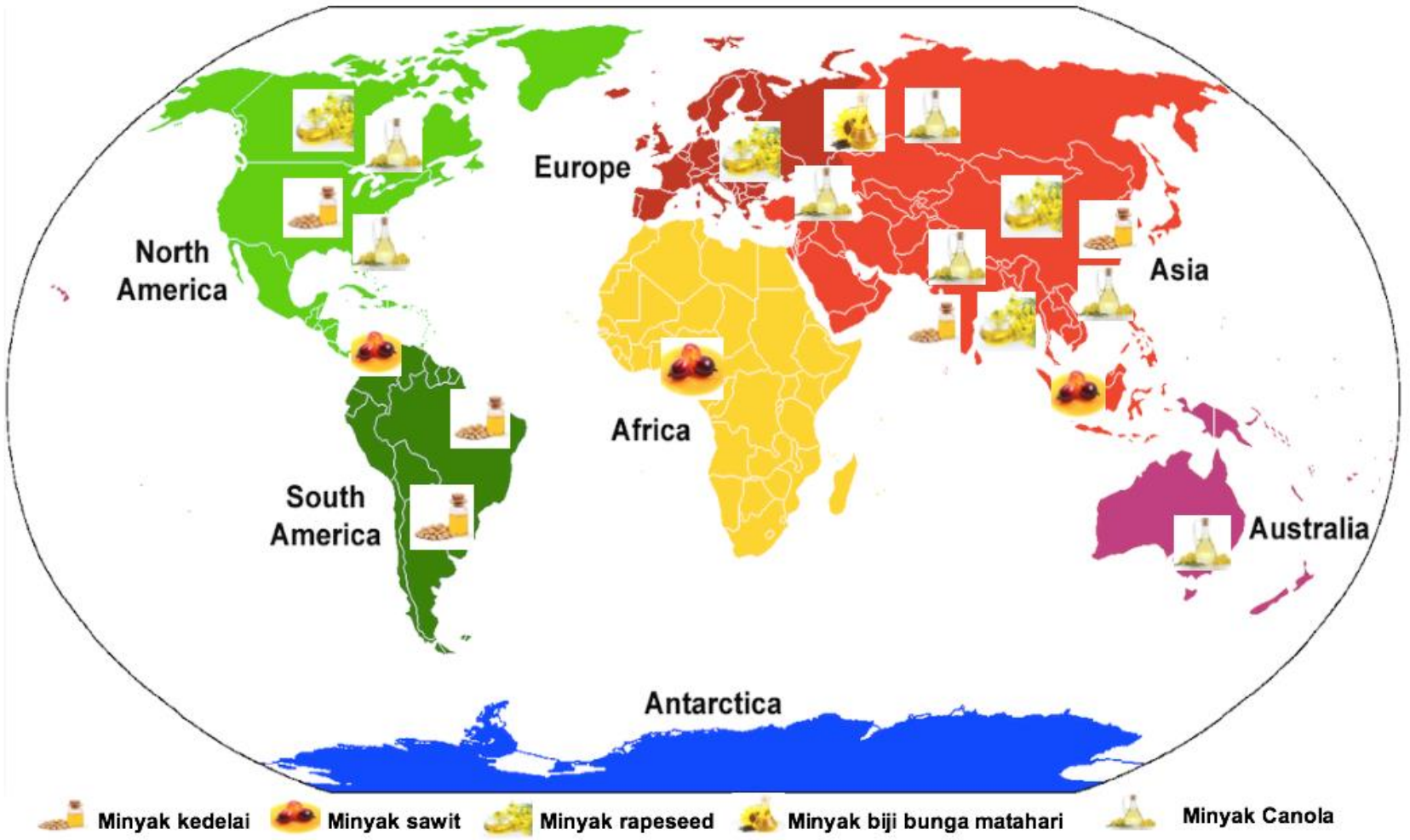
Keywords: *Tamarindus indica* L., seed oil, saturated fatty acids, and unsaturated fatty acids.

Abstract. The research was conducted to investigate the oil and fatty acids contained in *Tamarindus indica* Linn (tamarind) seeds oil. Tamarind seeds oil was isolated by extraction and fractionation. The fatty acids content in oil were identified as fatty acid methyl ester. Fatty acid methyl ester was produced from *trans*-esterification reaction of tamarind seed oil with methanol and boron trifluoride catalyst ($MeOH/BF_3$). Identification of fatty acid methyl ester was carried out by gas chromatograph mass spectrometry (GC-MS). The fatty acids in the *Tamarindus indica* seed oil are saturated and unsaturated fatty acids. The saturated fatty acids are octanoic (12.66%), decanoic (1.68%), dodecanoic (25.18%), tetradecanoic (5.17-7.83%), hexadecanoic (9.90-16.06%), octadecanoic (3.82-4.80%), eicosanoic (0.39-1.55%), docosanoic (1.00-2.01%), and tetracosanoic (1.92-4.54%) acids. The unsaturated fatty acids are 11-octadecenoic (19.93%), 11-eicosenoic (0.76-1.03%), 9,12-octadecadienoic (21.91-38.68%), and 9-octadecenoic (17.76%) acids. The physical and antibacterial properties of the seed oil are also reported.

Peta Minyak Nabati Dunia



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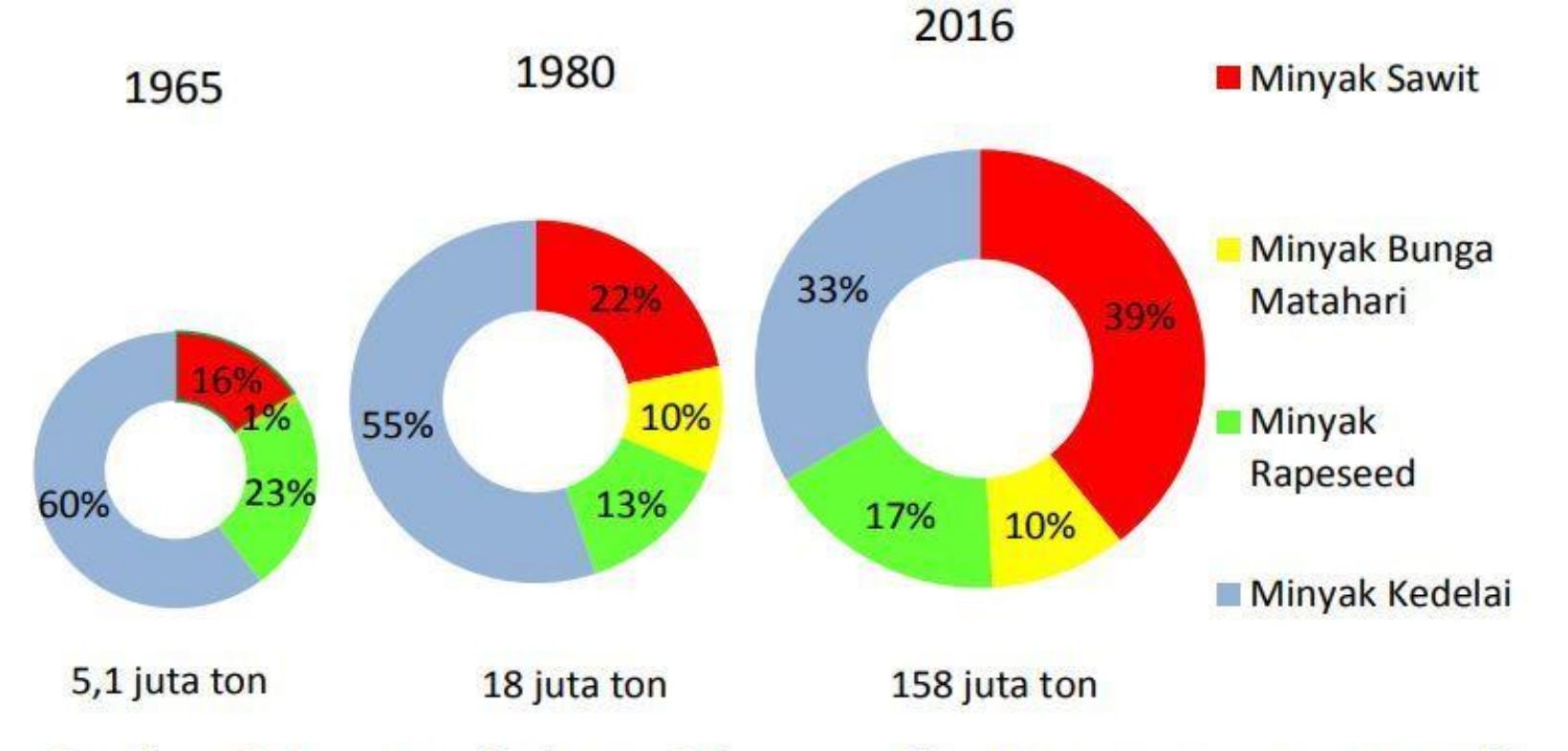

(USDA, 2017)

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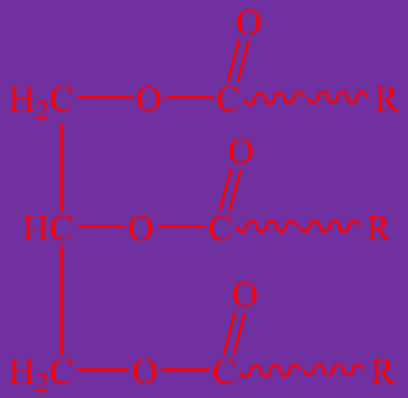
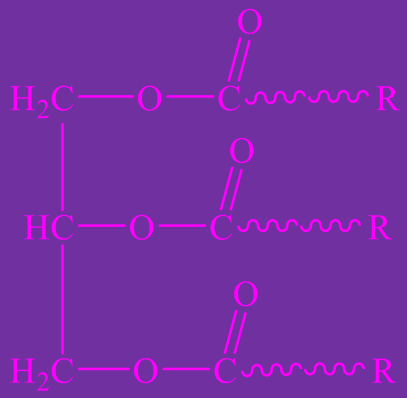
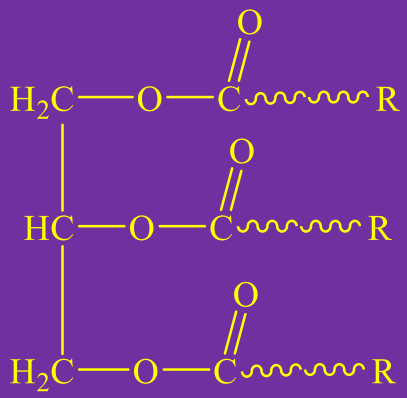
AREA RISET (KAMI) BERBASIS MINYAK NABATI

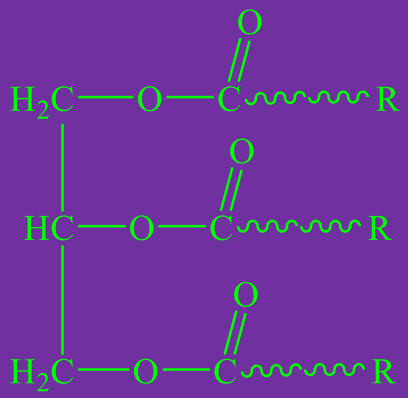
KLASIFIKASI FATTY ACIDS

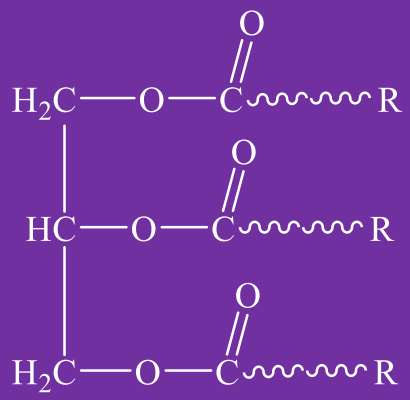
SCFA	C_5-C_8
MCFA	C_8-C_{14}
LCFA	C_{16}-C_{18}


H2C—O—C—R
HC—O—C—R
H2C—O—C—R

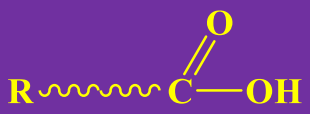

H2C—O—C—R
HC—O—C—R
H2C—O—C—R


H2C—O—C—R
HC—O—C—R
H2C—O—C—R


H2C—O—C—R
HC—O—C—R
H2C—O—C—R


H2C—O—C—R
HC—O—C—R
H2C—O—C—R

Derivat Asam Lemak

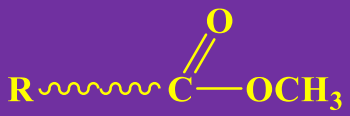


Fatty Acids

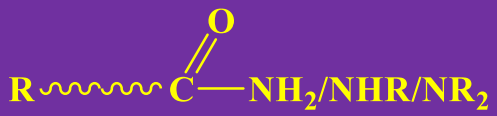
Fatty Aldehyd

Fatty Alcohol

Fatty Alkane/Alkene

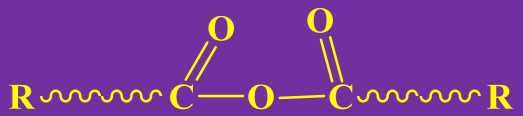


FAME

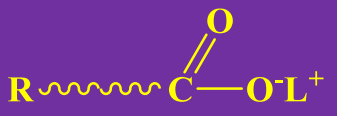


Fatty Amida

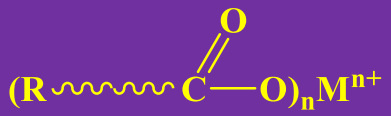
Halide Fatty Acids
X = Cl or Br



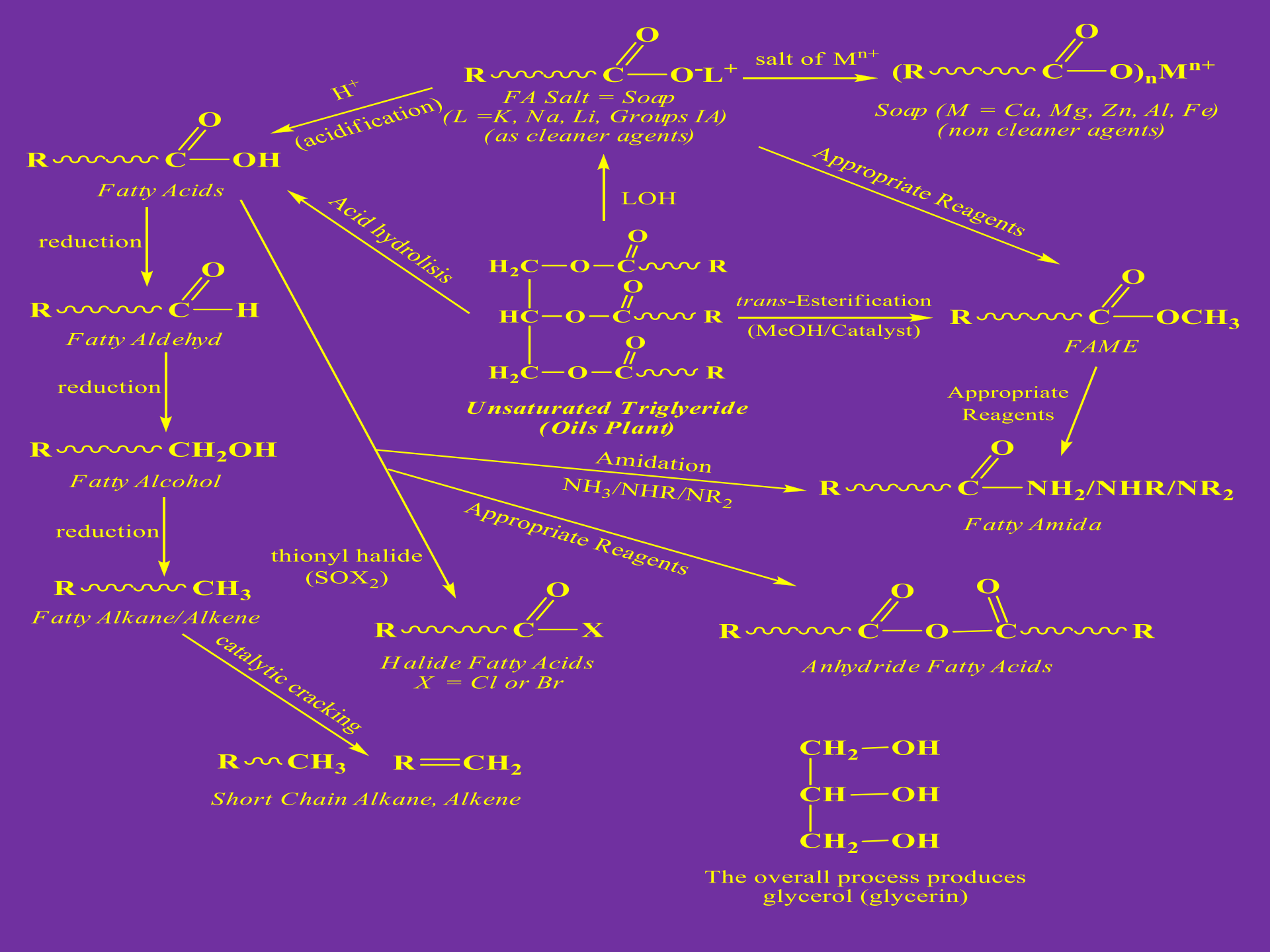
Anhydride Fatty Acids

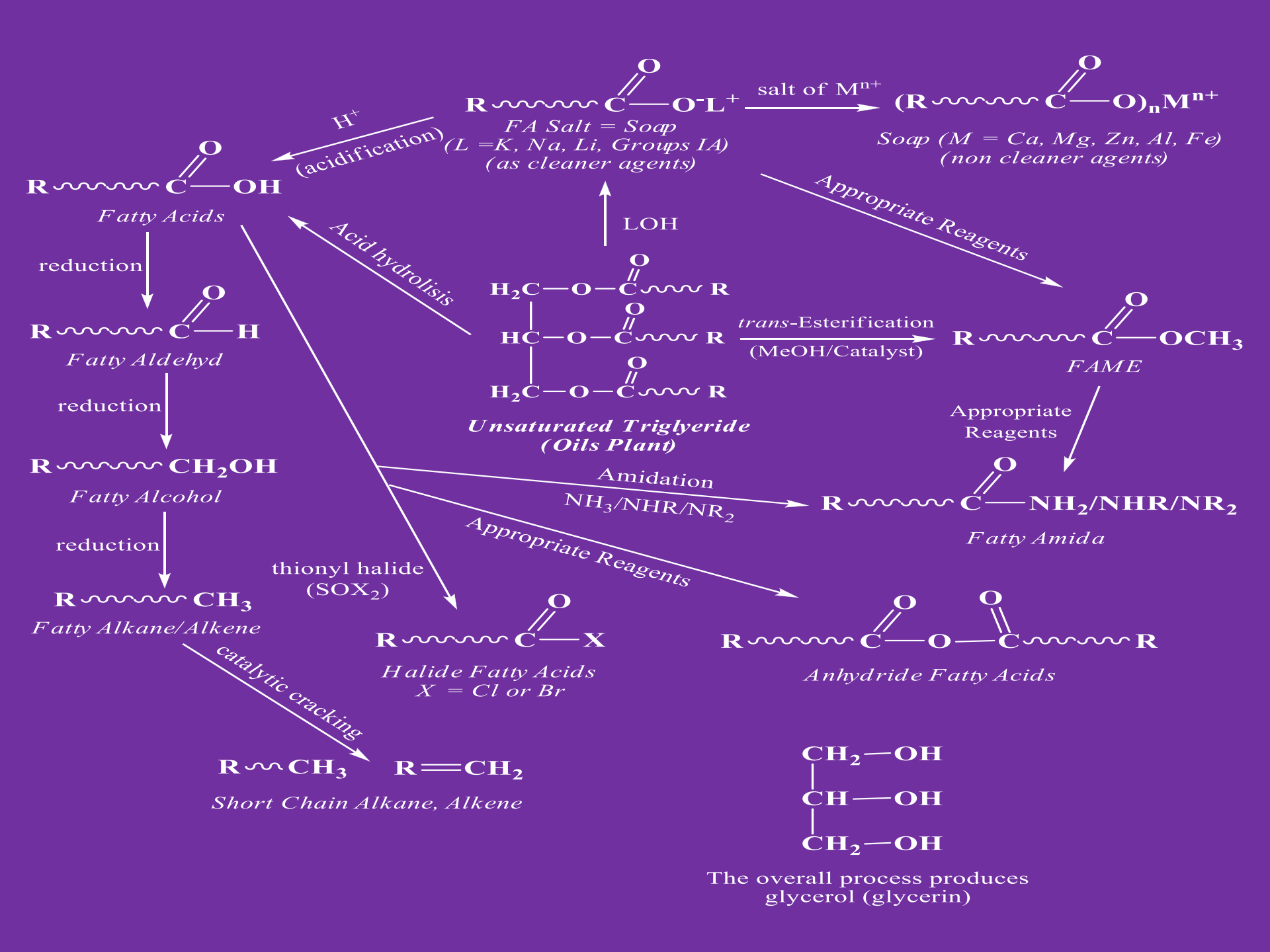


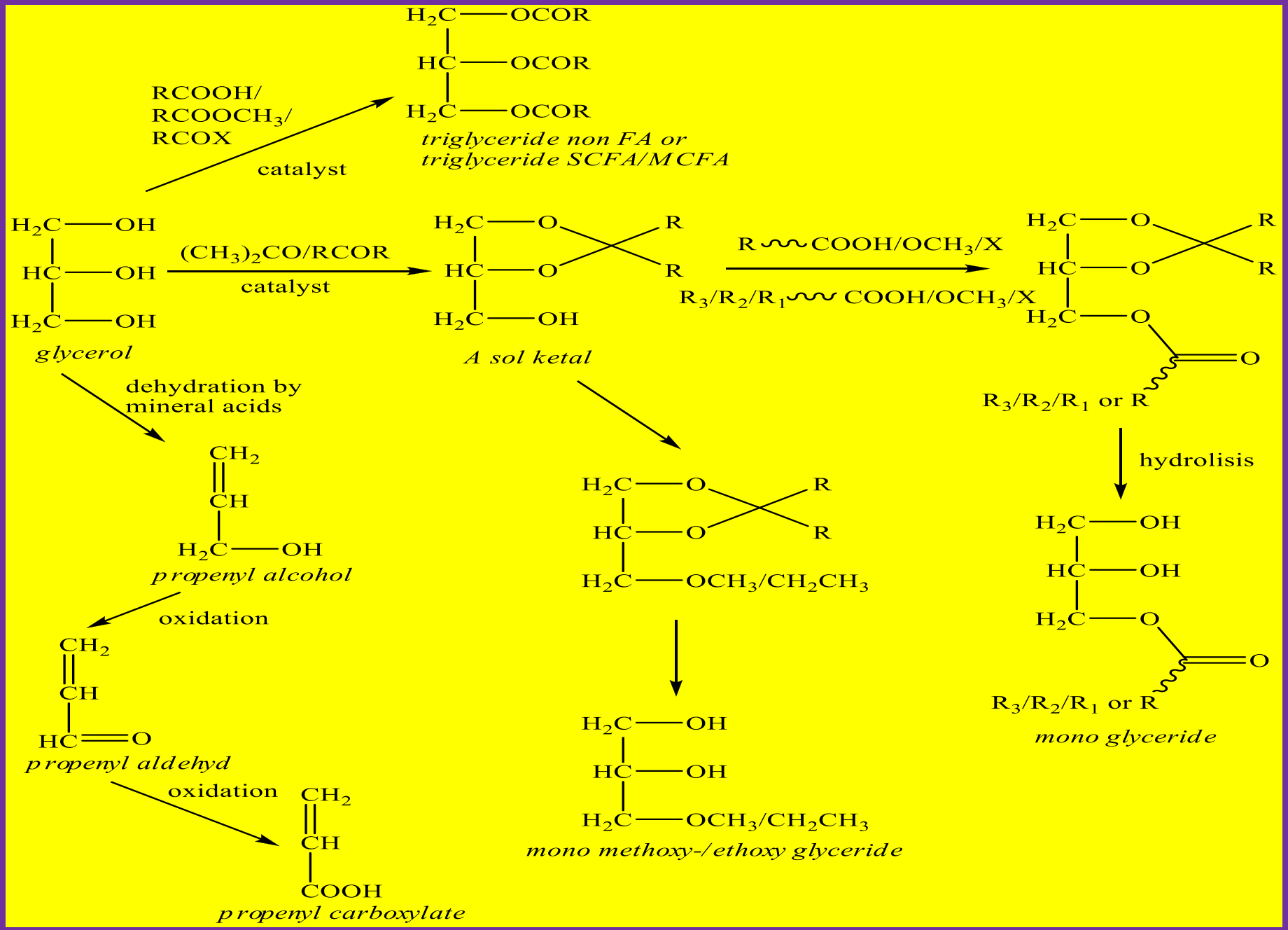
Soap (L =K, Na, Li, Groups IA)
(as cleaner agents)

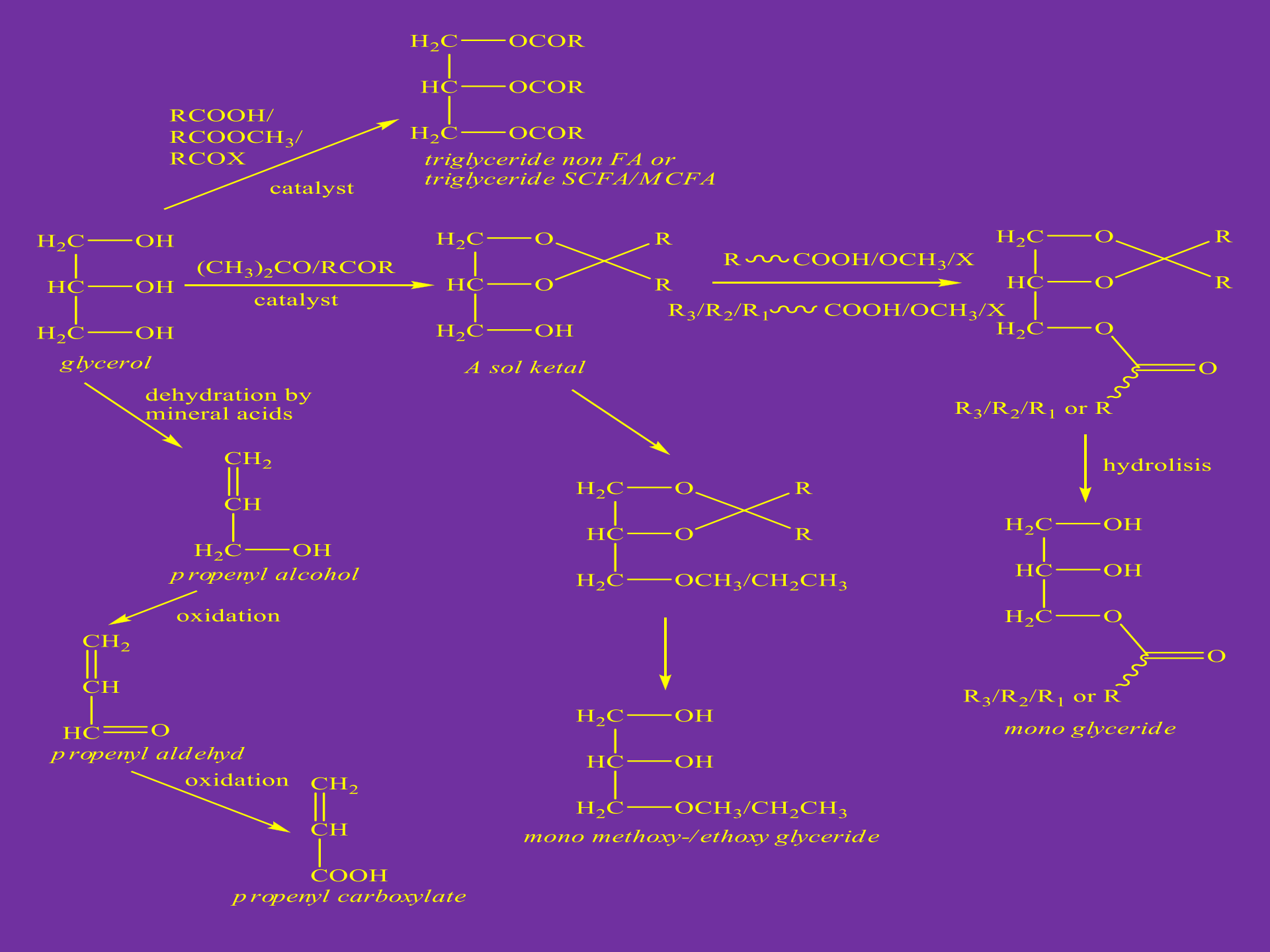


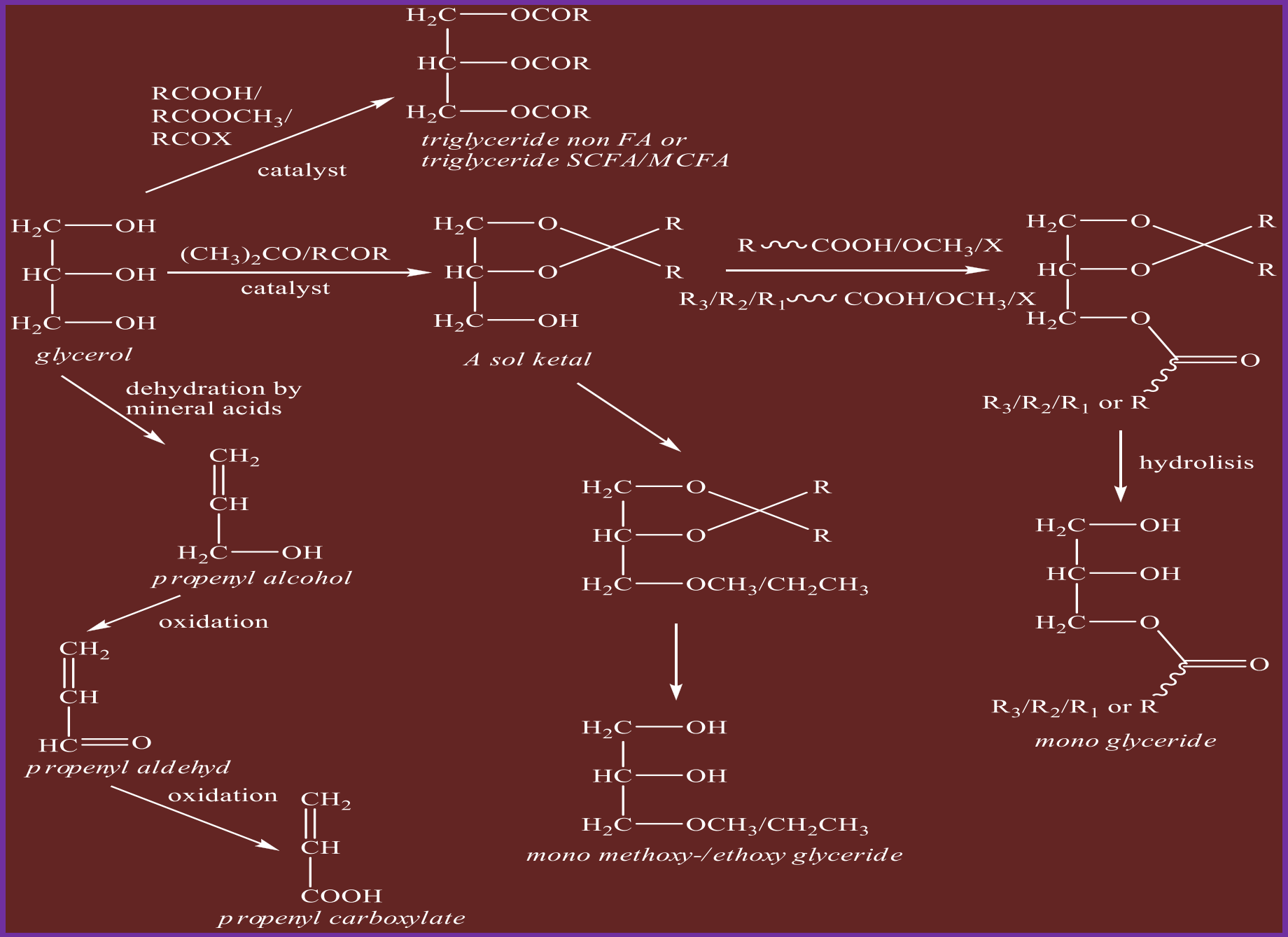
Soap (L = Ca, Mg, Zn, Al, Fe)
(non cleaner agents)


R—C(=O)—O⁻L⁺
FA Salt = Soap
(L =K, Na, Li, Groups IA)
(as cleaner agents)
salt of Mⁿ⁺
(R—C(=O)—O)ₙMⁿ⁺
Soap (M = Ca, Mg, Zn, Al, Fe)
(non cleaner agents)
H⁺
(acidification)
R—C(=O)—OH
Fatty Acids
LOH
Acid hydrolisis
Appropriate Reagents
reduction
R—C(=O)—H
Fatty Aldehyd
reduction
R—CH₂OH
Fatty Alcohol
reduction
R—CH₃
Fatty Alkane/Alkene
H₂C—O—C(=O)—R
HC—O—C(=O)—R
H₂C—O—C(=O)—R
Unsaturated Triglyeride
(Oils Plant)
trans-Esterification
(MeOH/Catalyst)
R—C(=O)—OCH₃
FAME
Appropriate
Reagents
Amidation
NH₃/NHR/NR₂
R—C(=O)—NH₂/NHR/NR₂
Fatty Amida
thionyl halide
(SOX₂)
Appropriate Reagents
R—C(=O)—X
Halide Fatty Acids
X = Cl or Br
R—C(=O)—O—C(=O)—R
Anhydride Fatty Acids
catalytic cracking
R—CH₃
R═CH₂
Short Chain Alkane, Alkene
CH₂—OH
CH—OH
CH₂—OH
The overall process produces
glycerol (glycerin)


R—C(=O)—O⁻L⁺
FA Salt = Soap
(L =K, Na, Li, Groups IA)
(as cleaner agents)
salt of Mⁿ⁺
(R—C(=O)—O)ₙMⁿ⁺
Soap (M = Ca, Mg, Zn, Al, Fe)
(non cleaner agents)
H⁺
(acidification)
R—C(=O)—OH
Fatty Acids
LOH
Acid hydrolisis
Appropriate Reagents
reduction
R—C(=O)—H
Fatty Aldehyd
reduction
R—CH₂OH
Fatty Alcohol
reduction
R—CH₃
Fatty Alkane/Alkene
H₂C—O—C(=O)—R
HC—O—C(=O)—R
H₂C—O—C(=O)—R
Unsaturated Triglyeride
(Oils Plant)
trans-Esterification
(MeOH/Catalyst)
R—C(=O)—OCH₃
FAME
Appropriate
Reagents
Amidation
NH₃/NHR/NR₂
R—C(=O)—NH₂/NHR/NR₂
Fatty Amida
thionyl halide
(SOX₂)
Appropriate Reagents
R—C(=O)—X
Halide Fatty Acids
X = Cl or Br
R—C(=O)—O—C(=O)—R
Anhydride Fatty Acids
catalytic cracking
R—CH₃
R═CH₂
Short Chain Alkane, Alkene
CH₂—OH
CH—OH
CH₂—OH
The overall process produces
glycerol (glycerin)


RCOOH/
RCOOCH3/
RCOX
catalyst
triglyceride non FA or
triglyceride SCFA/MCFA
glycerol
(CH3)2CO/RCOR
catalyst
A sol ketal
R~COOH/OCH3/X
R3/R2/R1~COOH/OCH3/X
R3/R2/R1 or R
hydrolisis
mono glyceride
dehydration by
mineral acids
propenyl alcohol
oxidation
propenyl aldehyd
oxidation
propenyl carboxylate
mono methoxy-/ethoxy glyceride


RCOOH/
RCOOCH3/
RCOX
catalyst
triglyceride non FA or
triglyceride SCFA/MCFA
glycerol
(CH3)2CO/RCOR
catalyst
A sol ketal
R~COOH/OCH3/X
R3/R2/R1~COOH/OCH3/X
R3/R2/R1 or R
hydrolisis
mono glyceride
dehydration by
mineral acids
propenyl alcohol
oxidation
propenyl aldehyd
oxidation
propenyl carboxylate
mono methoxy-/ethoxy glyceride


RCOOH/
RCOOCH3/
RCOX
catalyst
triglyceride non FA or
triglyceride SCFA/MCFA
glycerol
(CH3)2CO/RCOR
catalyst
A sol ketal
R COOH/OCH3/X
R3/R2/R1 COOH/OCH3/X
R3/R2/R1 or R
hydrolisis
mono glyceride
dehydration by
mineral acids
propenyl alcohol
oxidation
propenyl aldehyd
oxidation
propenyl carboxylate
mono methoxy-/ethoxy glyceride