



TECHNOLOGICAL ADVANCES IN PALM-BASED FOOD FORMULATIONS

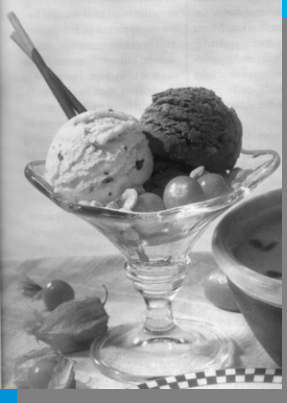
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Palm oil – The Sustainable 21st Century Oil
23-24 March, London

Dietary lipids



• Sources

- Vegetable oils— e.g. PO, SFO, SBO, canola - cooking oils, frying oils/fats, salad oils, bakery shortening and margarines
- Animal fats – e.g. meat, poultry, fish and dairy products
- Lipids are essential to a healthy body, growth and development

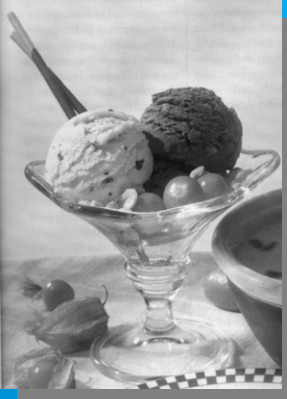
Current trends



- Attention of scientists, regulators, the media and consumers:
 - Total lipid intake
 - Saturated fat intake
 - Cholesterol
 - *trans* fats

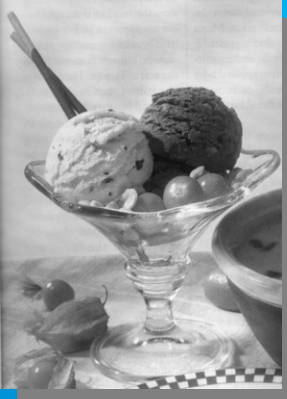
Current trends (cont.)

- Changing lipid-health guidelines to resolve the health issues – Challenges to food industry
- Consumer health issues – Demand for a good diet and a healthy lifestyle
- R&D to formulate:
 - *trans* free products
 - lower saturates
 - use of natural antioxidants
 - organic products
 - fat replacers



Zero/reduced *trans* fat

- *Trans* fat content on food label implemented
- Efforts to reduce *trans* fats/what are the alternatives?
 - **Natural fats**
 - **Interesterification**
 - **Fractionation**
 - **Blending**
 - **Biotechnology**



Natural fats (*Semi-solid/solid*)

- **Palm oil**
- **Palm kernel oil**
- **Coconut oil**
- **Cocoa butter**
- **Tallow**
- **Lard**
- **Milk fat**

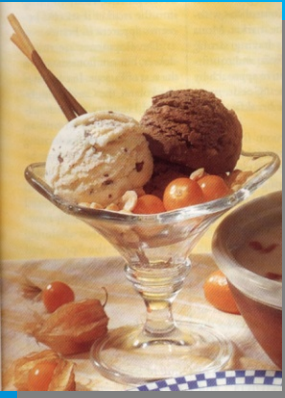
Fatty acid composition of RBD Palm Oil, Palm Olein and Palm Stearin (% by weight)

Fatty acid composition	RBD Palm Oil	RBD Palm Olein	RBD Palm Stearin
C12:0	0.1 - 0.4	0.2 - 0.4	0.1 - 0.3
C14: 0	1.0 - 1.4	0.9 - 1.2	1.1 - 1.7
C16: 0	40.9 - 47.5	36.8 - 43.2	49.8 - 68.1
C18:0	3.8 - 4.8	3.7 - 4.8	3.9 - 5.6
C18:1	36.4 - 41.2	39.8 - 44.6	20.4 - 34.4
C18:2	9.2 - 11.6	10.4 - 12.9	5.0 - 8.9
C18:3	0.1 - 0.6	0.1 - 0.6	0.0 - 0.5
C20:0	0.2 - 0.7	0.3 - 0.5	0.0 - 0.5

Triglyceride composition (by carbon no.) of RBD Palm Oil, Palm Olein and Palm Stearin

Triglyceride composition (by carbon number)	RBD Palm Oil	RBD Palm Olein	RBD Palm Stearin
C44	0.0 - 0.2	0.0 - 0.3	0.0 - 0.4
C46	0.7 - 2.0	0.4 - 1.4	1.5 - 6.8
C48	4.7 - 9.7	2.4 - 3.9	14.3 - 34.7
C50	38.9 - 41.6	37.9 - 40.9	37.9 - 46.5
C52	33.1 - 41.1	41.9 - 43.7	16.4 - 31.5
C54	10.3 - 12.1	11.8 - 13.5	4.2 - 9.0
C56	0.5 - 0.8	0.5 - 11.0	0.2 - 0.7
IV (Wijs)	50.1 - 54.9	55.6 - 61.9	27.8 - 45.1
SMP (°C)	33.0 - 39.0	19.2 - 23.6	46.6 - 53.8

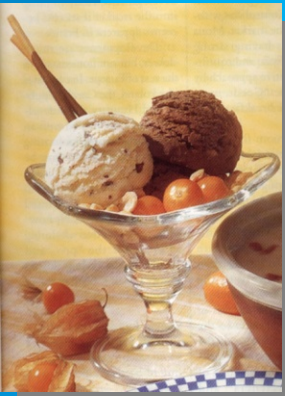
Why PALM OIL?



- **Versatility** - Chemical composition of palm oil suits most product formulations
- **Wide range of products**
- **Semisolid in nature** i.e. high palmitic content, 20% solids at 20C- suited for formulation of plastic fat products
- **Nutritive value** - Rich in natural antioxidants i.e. tocopherol, tocotrienol and carotenoids

Trans Free Palm-based Formulations

- *Trans free soft margarine*
- *Trans free stick margarine*
- *Trans free bakery fats*
- *Trans free puff pastry margarines*
- *Trans free vegetable ghee*
- *Trans free imitation/non-dairy products*
- *Trans free animal fat replacer*
- *Trans free chocolate spread*
- *Trans free non-lauric coating fats*



Significance of Solid Fats Hard Stock

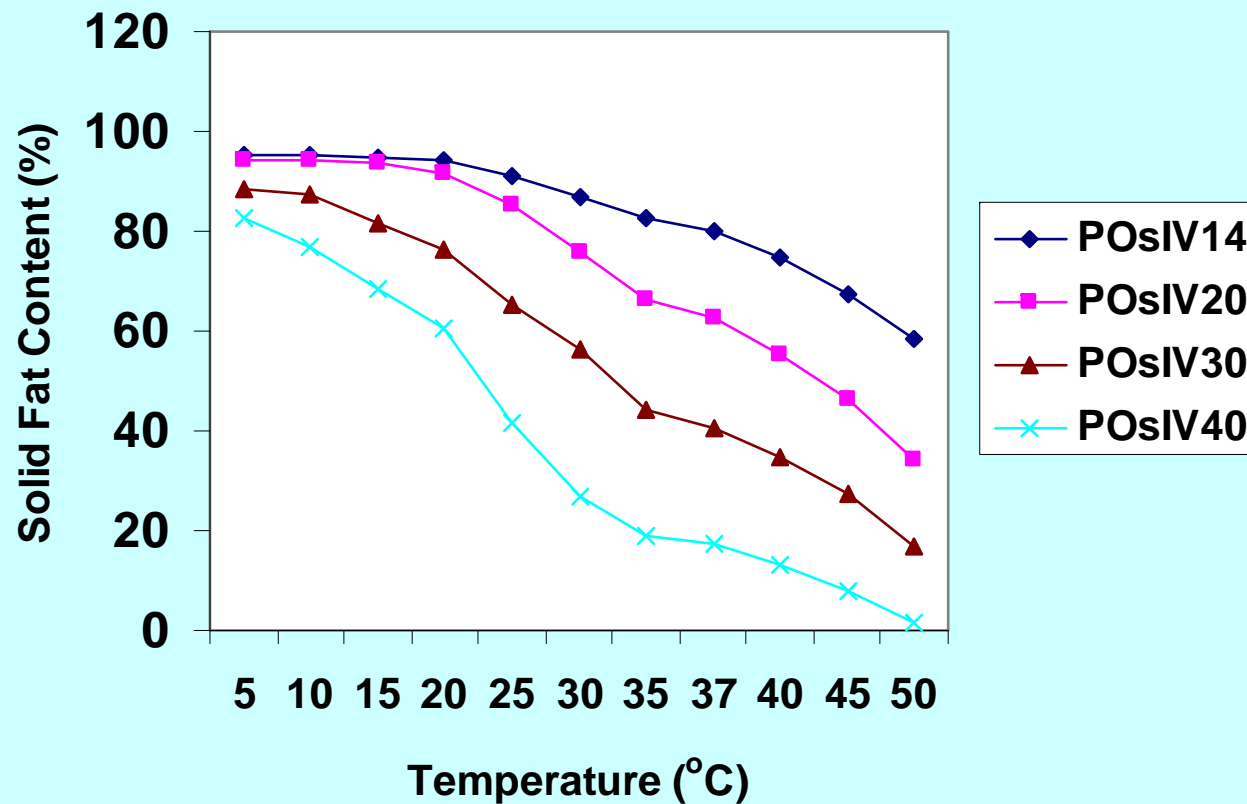
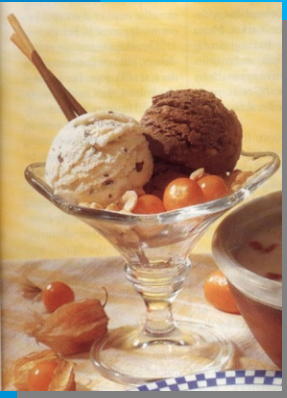
Solid fats products - contribute to functional properties of food

Provide texture and structure

- firmness in margarines and shortenings
- aeration in cake batter, creams
- flakiness in puff pastry



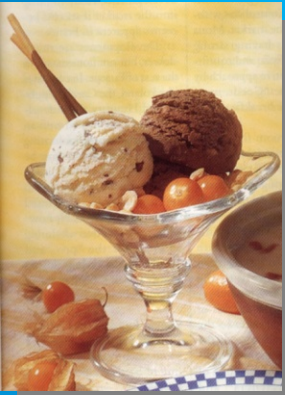
SFC of palm stearins



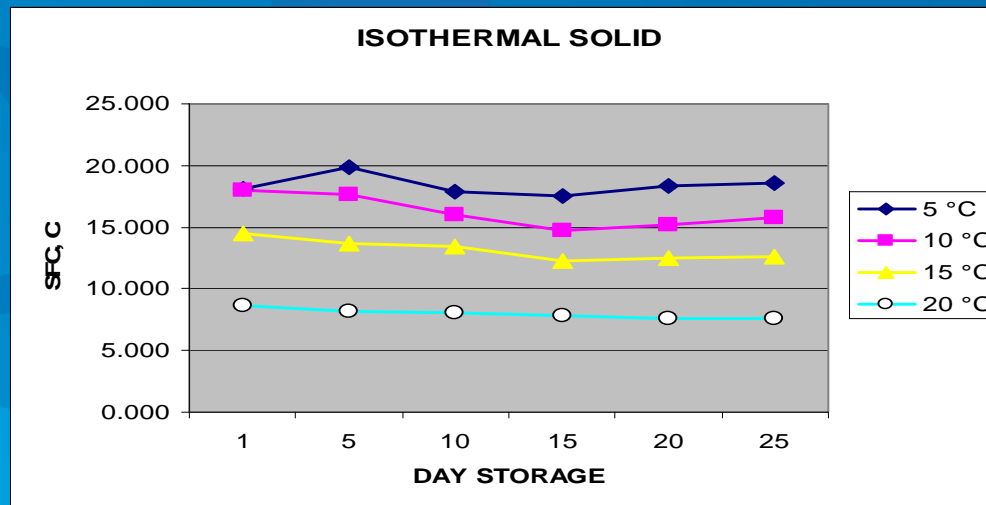
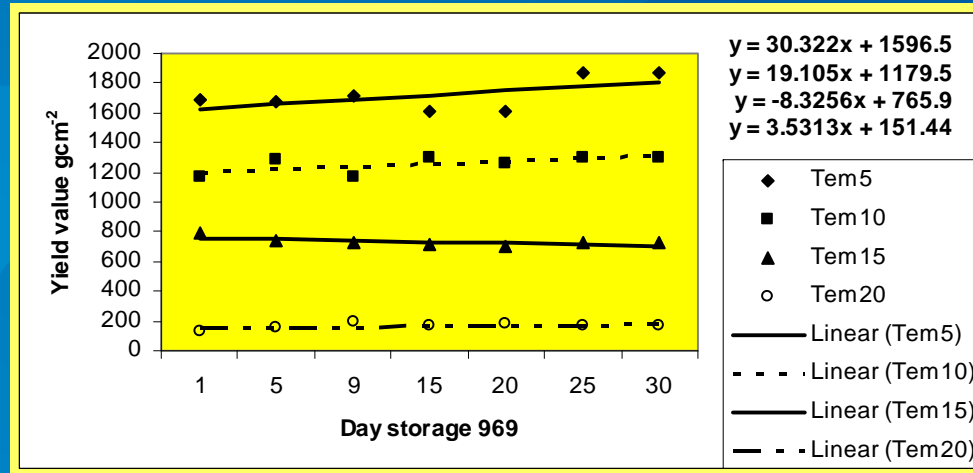
Hard stock + Soft Oils

Hard Stock	Soft Oil	
	POo(IV=60)	SFO
IE[POS (IV=0): PKO]	√	√
IE[POS(IV=14):PKS]	√	√
POS(IV=14):PKS	√	√
POS (IV=0):PKO	√	√
POS (IV=14): PKO	√	√
POS (IV=20):PKO	√	√

POS hard stock proven suitable for low SAFA stick margarines



Palm stearin as hard stock in margarine consistency test,



Sample processed at 400 rpm pin-rotor, no post-hardening

Fatty Acid Compositions of Stick Margarine Formulations Using Palm Stearin as Hard Stock

	8:0	10:0	12:0	14:0	16:0	18:0	18:1c	18:2cc	sat	trans
845	0.6	0.5	6.2	2.2	10.5	5.9	24.6	48.8	26.2	0
844	0.4	0.3	4.5	2.4	35.1	5.4	39.9	11	48.5	0
843	0.3	0.2	3	1.2	14.4	3.4	24.6	52.1	22.8	0
842	0.3	0.3	3.5	2.2	38.9	3.9	38.3	10.9	51.9	0
901	0.7	0.5	5.5	2.1	20.9	4.6	18.3	46.8	34.9	0
920	0.2	0.2	4.2	1.8	24.0	4.8	17.5	47.6	34.9	0

***trans* free formulations with low total saturated fat achieved using hard stock produced from POS, PKO and soft oils**

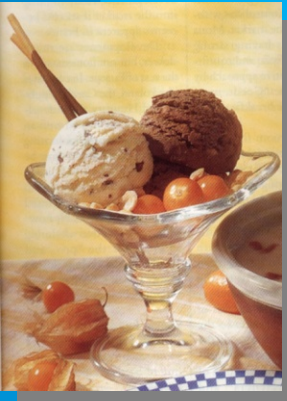


Shortening formulations and performance

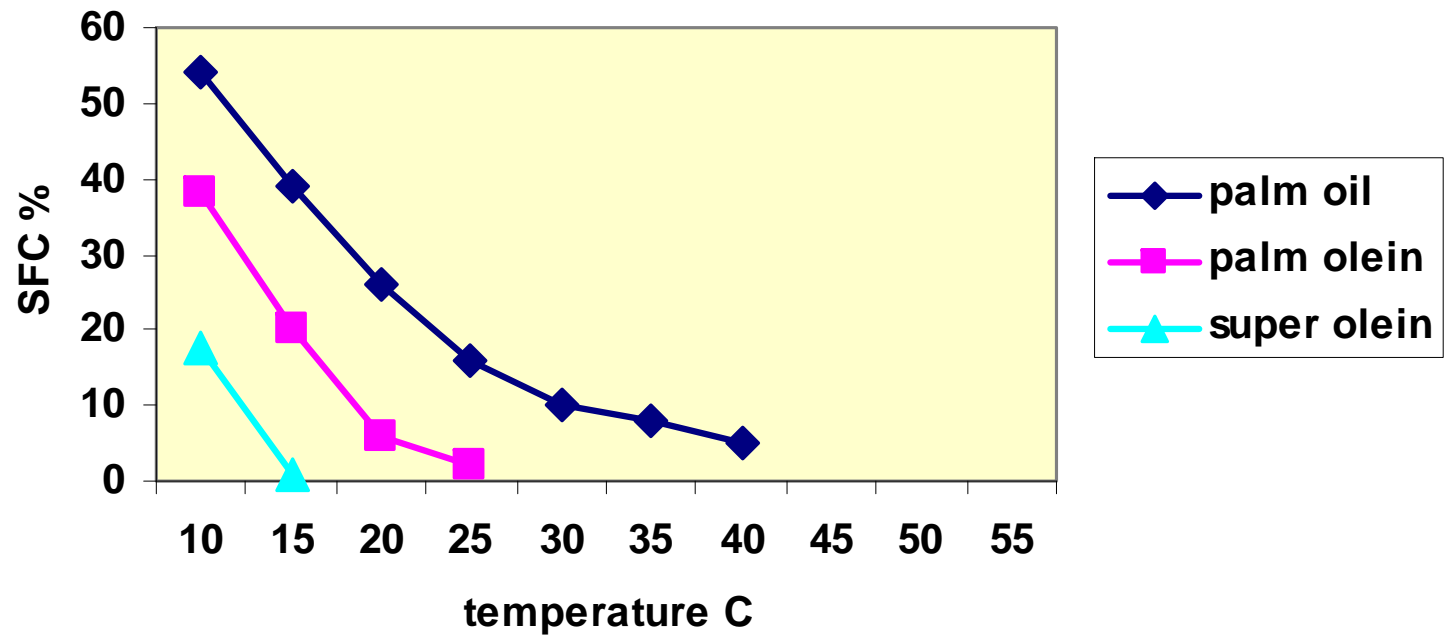
Sample	4847-1	3876-1	3876-2	3847-2	Contr 1	Contr 2
Base	Oil	Liq short	Oil	Liq short	S-solid	Liq short
Rapeseed oil	100	74.5	100	74.5	30	74.5
Palm stearin	-	5	-	5	-	5
IE (60% Pos:40% PK)	-	-	-	-	30	-
Palm oil	-	15	-	15	40	15
HPO	-	5	-	5	-	5
STS	-	0.5	-	0.5	-	0.5
Emulsifier:PGMS	8	8	4	4	-	-
Emulsifer: Mono	2	2	1	1	1	-
SpVol (dose 12.5%)	3.25	3.78	3.09	3.46	3.18	2.75
SpVol (dose 6.25%)	3.54	3.53	3.21	3.17	2.79	2.58
Sat	15	28	11	24	42	21
TFA	<1	<1	<1	<1	<1	<1

(Source: Wassel, 2006)

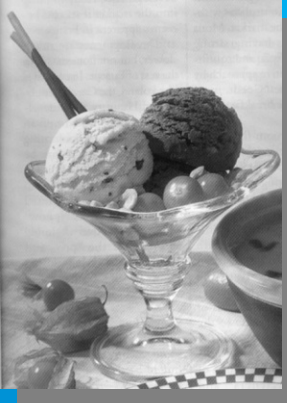
SFC of palm oil and oleins



SFC of palm oil and olein



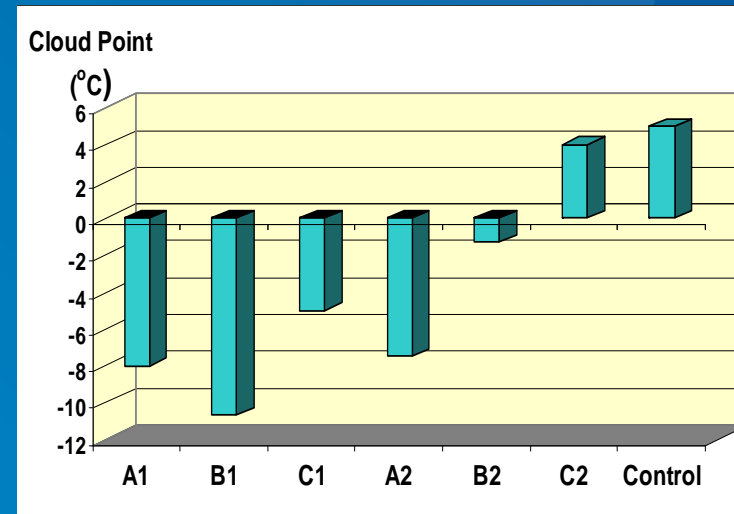
Cooking oil



- **Palm olein widely acceptable for frying**
 - low in polyunsaturates – higher induction period, higher resistance against oxidation
 - mixtures of components with antioxidant properties
 - forms lower total polar materials
 - enhance the original flavour of the fried products
- **Blended with other vegetable oils to improve cold stability**

Palm blends

- Binary and ternary blends of palm olein with other liquid vegetable oils, alternative to partially hydrogenated oils which contain *trans* fatty acids.
- Oil blends have lower cloud points, stay clear in temperate climate.
- Excellent choice for food applications, e.g. as frying, cooking and salad oils.



Induction period of Oils and Blends

Oil and blends	Induction period (hours)
RBD palm olein	44.0
Groundnut	15.0
Groundnut/palm olein	21.0
Maize	9.0
Maize/palm olein	12.0
Rapeseed	11.5
Rapeseed/palm olein	16.0
Soyabean	16.0
Soyabean/palm olein	19.0

Blending with palm olein improves oxidative stability of the other oils

SPRAYABLE COOKING OIL



ADVANTAGES OF SPRAYABLE COOKING OIL

- Provides a convenient way of handling - especially for campers, picnickers, travelers and army rations
- Provides a stick-free coating to cooking utensils
- It is developed for grilled, roasted and microwave products

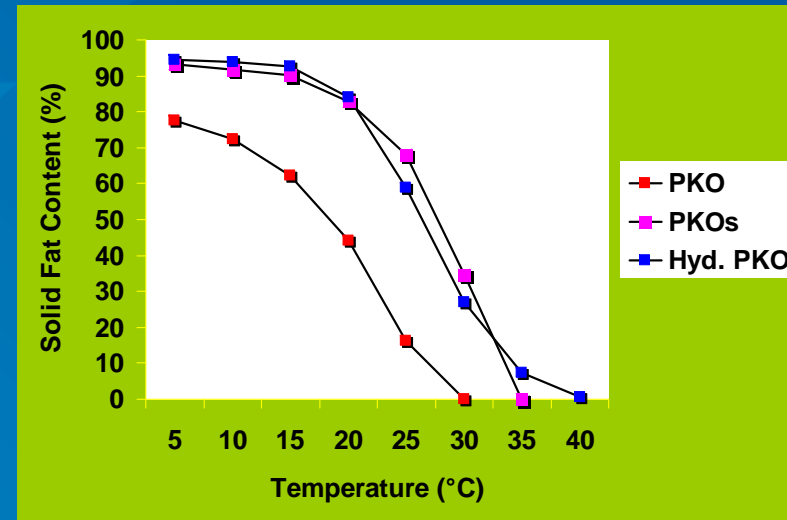


SOLID FAT CONTENT (%) OF ICE CREAM FATS

Product	Temperature (°C)						
	-5	0	5	10	20	25	35
PKO	86.1	84.2	78.9	72.2	45.5	21.5	0
PO	82.4	78.6	69.5	54.6	23.2	13.7	6.0
Butterfat	71.6	68.2	61.7	46.9	26.0	18.0	8.0

- **PO and PKO - good alternative to butter fat in ice cream.**
- **PKO with sharp melting properties is usually considered superior in this application.**
- **PO - offering the best compromise between quality and price.**

COFFEE WHITENERS / CREAMER



Criteria for selection of creamer fats

- (a) resistance to oxidation ($IV < 5$) and flavour reversion
- (b) have steep SFC profile
- (c) Melting point in the range of 30–40°C.



SAFAR™

– Specialty animal fat replacer



MEAT EMULSIONS

- Frankfurter
 - Beef/chicken patties
 - Hot dogs
- 
- 
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Fat substitutes

- New research area in fats and oils R&D
- **Fat substitutes are macromolecules that physically and chemically resemble triglycerides (conventional fats and oils) and which can theoretically replace the fat in foods.**
- Chemically synthesized or derived from conventional fats and oils by enzymatic modification.
- Ideally
 - do not interfere with nutrient or drug utilization
 - safe
 - inexpensive
 - non-caloric



Fat substitutes (cont.)

Examples of selected applications and functions of fat replacers

Specific application	Fat replacer	General functions ^a
Baked goods	Lipid based	Emulsify, provide cohesiveness, tenderize, carry flavor, replace shortening, prevent staling, prevent starch retrogradation, condition dough
	Carbohydrate based	Retain moisture, retard staling
	Protein based	Texturize
Frying	Lipid based	Texturize, provide flavor and crispiness, conduct heat
Salad dressing	Lipid based	Emulsify, provide mouthfeel, hold flavorants
	Carbohydrate based	Increase viscosity, provide mouthfeel, texturize
	Protein based	Texturize, provide mouthfeel
Frozen desserts	Lipid based	Emulsify, texturize
	Carbohydrate based	Increase viscosity, texturize, thicken
	Protein based	Texturize, stabilize
Margarine, shortening	Lipid based	Provide spreadability, emulsify, provide flavor and spreads, butter plasticity
	Carbohydrate based	Provide mouthfeel
	Protein based	Texturize
Confectionery	Lipid based	Emulsify, texturize
	Carbohydrate based	Provide mouthfeel, texturize
	Protein based	Provide mouthfeel, texturize

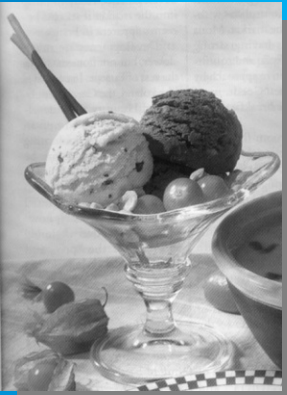
^aFunctions are in addition to fat replacement.

Source: Akoh (1998)



Functional foods

- Those providing health benefits beyond basic nutrition and include whole, enriched or enhanced foods which have a potentially beneficial effect on health when consumed as part of a varied diet on a regular basis at effective levels



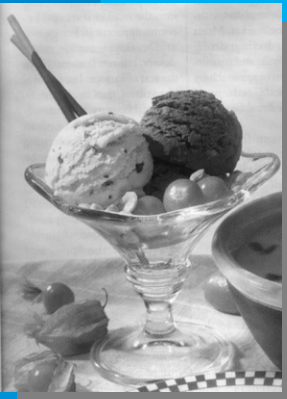
Natural vs synthetic

- Palm oil is a rich source of natural components that can be used as food ingredients.
- Being emphasized, especially as food colourings and source of vitamin A:
 - carotenoids

Carotenoids composition of palm oil

Carotenoid	%	Crude (ppm)	Red PO (ppm)
Phytoene	1.3	10.4	6.5
<i>cis</i> b-carotene	0.7	5.6	3.5
b-carotene	56	448	280
a-carotene	35.2	281.6	17.6
<i>cis</i> a-carotene	2.5	20	12.5
Lycopene	1.3	10.4	6.5
Others	3.7	29.6	18.5
Total	100	800	500

Source: Sundram (2005)



Other palm micronutrients



- Ubiquinones
- Phospholipids
- Squalene
- Phytosterols
- Phenolics
- Flavonoids

Applications:

- Dietary supplements
- Beverage
- Dietetic foods
- Pet foods

Functional foods (cont.)

Relevant technologies:

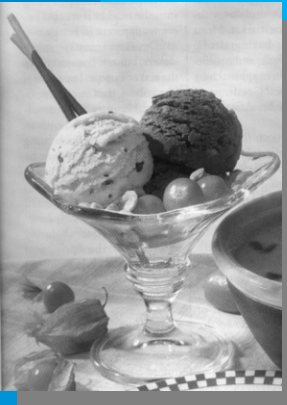
- critical fluid technology
- molecular distillation.

Examples of materials processing using critical fluid media with implication or direct application in the nutraceutical or functional food industry

Process	Example of application
Concentrated powder form, jet dispersion	Dispersion of paprika soup powders
Semicontinuous gas antisolvent process	Cholesterol morphology and precipitation
Rapid expansion of supercritical solution	Phytosterol micronization, Encapsulation of β -sitosterol on low MW polymer matrix
Concentrated powder form process	Controlled release of flavors and vitamins
Supercritical antisolvent process	Incorporation of cholesterol or proteins in biodegradable matrix

Source: King (2005)

Microstructure and nanotechnology



- New research area in fats and oils R&D
 - **phase and state transitions of food**
 - characterization of system
 - protection of functional and active food components during processing and storage
 - **formation and stabilization of crystals**
 - **new methodology for understanding the food system**
- Nanotechnology
 - emerging science
 - being used in several industries
 - control of matter at an atomic or molecular scale of 1-100 nm

Microstructure and nanotechnology (cont.)



- **Application of nanotechnology in fat and oil products**
 - bioactives ~ nutritional ingredients that are active at a physiological level
- **Concerns about nanotechnology**
 - absorption and reaction i.e. nanoparticles crossing natural barriers and membranes
- **Overall, public is curious & positive**

Conclusions

- Palm oil and palm products continue to be important ingredients in food preparation and food manufacture.
- Proven versatility.
- Functional food market creates opportunities for palm oil industry
- More studies, relevant product development and marketing efforts would be beneficial.





THANK YOU



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