Processing and Stable Oils



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Trans Fatty Acid Contents of Hydrogenated Soybean Oils

Oil	lodine Value	% Trans
Margarine / spread base	65–68	40
Shortening base	80–82	32
Salad oil	110–112	9–11
Hydrogenated clear frying	94–96	18

Food Service Products

	%		%
Product	Trans	Product	Trans
Cube frying shortening	43	Cracker spray oil	35
All-purpose shortening	32	Cocoa butter replacer	13
Icing shortening	32	Industrial margarine	25
Donut frying shortening	43	Tub margarine oil	13
Dairy creamer fat	45	Stick margarine oil	22

U.S. Usage of Edible Vegetable Oils 2004–2005

Oil	Million Pounds	Billion Pounds	%
Soybean	17,300	17.3	78.6
Corn	1,683	1.683	7.7
Cottonseed	834	0.834	3.8
Canola	1,598	1.598	7.3
Peanut	250	0.250	1.1
Sunflower	245	0.245	1.1
Safflower	88	0.088	0.4
	21,995	21.995	100
Other			
Palm	631	Soybean, c corn. cotto	canola, onseed
Olive	538	account for 97.4%	
Palm Kernel	522		
Edible Tallow	1,617		
Coconut	879		

Production / Domestic Use of Sunflower Oil

Year Ending	Production 1000 Metric tons	Use	Export	Million Pounds
2001	387	149	251	333.8
2002	382	166	206	371.8
2003	183	119	52	266.6
2004	280	157	111	351.7
2005	162	94	58	210.6
2006*	310	324	75	725.8

* Projected

Trans-Free Solutions

Interesterification

Liquid oils / stearines: soy, cottonseed, palm Chemical Enzymatic Blending Liquid Soft Oils with Harder Components

Animal Fats / Edible Tallows

Fractionation of Tropical Fats

Palm Palm Kernel

Modified Hydrogenation Processes

Pressure-controlled Electrochemical Supercritical Fluids Noble Metal Catalysts Modified Catalysts

Modified Composition Oils

Low Linolenic: soy, canola High Oleic: soy, corn, sunflower High Saturate: soy

Naturally Stable Oils

Low in Linolenic Acid Corn Cottonseed High-oleic / mid-oleic sunflower

Combinations of Interesterification, Hydrogenation, Fractionation

Interesterification Chemical Enzymatic

- Reaction not specific—triglycerides conform to random distribution
- Solid fat index / solid fat curves are relatively flat
- Feedstock sensitive to moisture, free fatty acids
- Catalyst (sodium methoxide) sensitive to moisture
- Reaction prone to side products soaps, methyl esters, mono/diglycerides formed
- Requires post-processing—killing of catalysts, washing out soaps, bleaching to remove color bodies
- Batch process

- Reaction is specific (1,3 positions)
- Solid fat curves are steeper, sharply melting—better functionality
- Catalyst / enzyme expensive
- No side products
- No post-processing
- Continuous process



The interesterification process will produce a desirable slope to the SFI/SFC curve of the finished product

Enzymatic Interesterification



Oil Mill Gazeteer, June 2004

De Smet Enzymatic Interesterification

Kg Enzyme*/ Reactor	Kg Total Enzyme	Capacity T / Day
100	400	20–25
200	800	40–50
400	1600	80–100

* Lipozyme[®] / Novozyme

Oil Mill Gazeteer, June 2004

Solid Fat Index and Drop Melting Points of Enzymatically Interesterified Soy Oil / Soy Stearine Blends



Dry Multiple Fractionation of Palm Oil



Solid Fat Content of Palm Oil Fractions by NMR



Trans Acid Reduction During Hydrogenation

J. Hasman

- "Trans Suppression in Hydrogenated Oils," Inform 6 1206 (1995)
- Low temperatures, high pressures, high catalyst concentration produce about 50% less *trans* than normal
- High pressures and catalyst concentration are deterrents to commercial use
- Work about 10 years ahead of its time

King, et. al. "Hydrogenation of Soybean Oil in Mixtures of Super Critical Carbon Dioxide and Hydrogen," JAOCS, <u>78</u> 107–113 (2001)

List, et. al. "Hydrogenation of Soybean Oil: Effect of Pressure on Selectivity," JAOCS <u>77</u> 311–314 (2000)

- Trans suppression up to 80% slow reaction rates at low temperatures and high pressures (i.e. 120°C, 250–500 lbs.)
- Studies strongly suggest that a window exists where pressure and temperature can be used to make a selective reaction rather than non-selective

Warner, et. al. "Electrochemical Hydrogenation of Soybean Oil," JAOCS 77 (2000)

Shows promise in laboratory studies

Trans and Saturate Formation: Effect of Catalyst



Ariaansz and Okonek, World Conference Proceedings (1998)

Commercial Solutions for Trans Reduction

Company Solutions

- A Naturally stable oils, lauric / palm fats, blends, interesterified (chemical / enzymatic)
- B Low *trans /* low saturate baking shortenings, cocoa butter replacers, palm- / palm-kernel based
- C Low *trans*, reduced saturate baking shortenings, low linolenic soybean, canola oil
- D Zero *trans* liquid oils, low *trans* / low saturate baking shortenings
- E Palm-based baking shortenings, palm-based frying fats, low *trans* coating fats
- F Palm-based structural fats for spreads / baking shortenings, fractionation / interesterification

THANK YOU!