MODIFIED PHYSICAL REFINING OF CANOLA OIL
NOVEL ADSORPTIVE TREATMENT OF CANOLA/RAPESEED OIL WITH SILICA ADSORBENTS

G.J. Toeneboehn, W.A. Welsh

W.R. Grace & Co.-Conn. 7379 Rt. 32, Columbia, MD 21044

Canola production and processing represent a rapidly growing segment of the North American edible oil industry, where the majority of the oil processed is from canola seed rather than European varieties of rapeseed. All discussion and data presented are in reference to canola, but are believed applicable to all varieties of rapeseed oil.

The objective of the refining process is to produce a high quality oil product by selective, efficient and cost effective separation steps which remove most or all of the principal impurities such as phosphatides, associated trace metals, color bodies and free fatty acids from triglyceride oils, while minimizing the amount of undesirable and troublesome by-products. Canola and rapeseed oils share a common characteristic of high chlorophyll content, presenting the refiner with a special challenge. When employing traditional refining methods, the refiner is faced with high levels of bleaching earth usage and undesirable side streams, increasing the refining and disposal costs.

The introduction of amorphous silica in glyceride oil refining presented the concept of specific adsorbents for specific functions. The amorphous silicas have been found to be extremely efficient for adsorption of phospholipids and associated trace metals (Fig. 1). Unlike bleaching earth, the phospholipid capacity of the silica adsorbents is further enhanced in the presence of soaps (Fig. 2).

This synergism between soap and phospholipid adsorption is taken advantage of in the new silica refining process called Modified Physical Refining (MPR). The MPR process combines the best features of both caustic and physical refining while addressing the most serious drawbacks of each (Fig. 3). Key to this new process is the use of high capacity silica adsorbents for the removal of soaps, phospholipids and trace contaminants, commonly known as bleaching earth poisons. Removal of these poisons greatly enhances the chlorophyll capacity of the bleaching earth resulting in reduced usage of bleaching earth.

The two traditional methods of processing canola oil are physical and caustic refining. The type of feedstock processed, end product quality demands, environmental restrictions, operating and investment costs of the processing equipment influence the choice of the refining method employed.

Silica refining offers a new option for the refiner to optimize the refining process, while minimizing the volume of undesired by-product streams and producing good quality finished oil.

Alkali refining is typically practiced when refining crude oil directly from the extraction plant. The alkali treatment is more effective in removing phospholipids, resulting in a more effective utilization of bleaching earth and reduced adsorbent usages. The potential for a better and more consistent quality finished product is one of the advantages; however, the soapstock created by the neutralization of the free fatty acids and large quantities of wash water required in the wash step can become an environmental liability.

The elimination of the soapstock and wash water stream is a major economic and environmental driving force for physical refining. Most of the canola oil processed in North America is superdegummed, with phosphorus content ranging from 10 to 50 ppm, so physical refining is widely practiced. As a result of high phosphorus levels in the feedstock oil, bleaching earth usages can be quite high leading to higher oil losses and larger volumes of spent filter cake.

The amorphous silica's capacity to adsorb phospholipids and soaps has been used to improve the efficiency of both physical and caustic refining. The unique aspect of silica refining has been further expanded to combine the advantages of both alkali and physical refining and eliminate the drawbacks to both. The Modified Physical Refining process employs the use of soaps generated by addition of small quantities of caustic solution to the degummed oil to enhance the adsorption of phospholipids on silica. This process can be applied to any glyceride oils containing less than 150 ppm phosphorus, including canola or rapeseed. The amount of soap required in the pretreatment step is dictated by the phosphorus content of the oil. The phospholipids and the soaps are then adsorptively removed on a hydrous amorphous silica adsorbent. To maximize bleaching earth capacity, the silica treated oil is then bleached employing the packed bed process; however, traditional continuous addition bleaching can be applied as well.

A commercially superdegummed canola oil was treated with 0.05 wt% of 18 °Be NaOH solution at 50 °C, generating 335 ppm soap. The soapy oil was heated to 70°C, and treated with 0.4 wt% of silica adsorbent, followed by a vacuum bleaching step and deodorization. The silica refined oil quality was compared in Table 1 to traditional caustic and physical refined canola oils. The overall quality of the fresh deodorized silica refined oil was equivalent in color, and had slightly better Rancimat times. It is worthwhile to mention, that 1.69 wt% of 18 °Be NaOH was required to alkali refine the same oil.

The better stability of the silica refined oil may be partially due to the higher tocopherol levels in the finished oil. The reduction of caustic or acid pretreatment coupled with the use of silica tends to maximize tocopherol levels in the process stream and not in the by-product streams (Table 2).

The laboratory deodorized oils were aged in a forced hot air Schaal oven at 60 °C for four and eight days to investigate the impact of silica refining on the long term stability of the refined, bleached and deodorized oils. Color stability, oxidative stability as expressed by Rancimat, and formation of total oxidation products were monitored (Table 3). The silica refined oil had a better color stability and equivalent oxidative stability to the traditional physically refined oil, and better long term oxidative stability than the traditional caustic refined oil.

Laboratory studies on water and acid degummed soybean and palm oil have been completed. Commercial tests on water degummed soybean oil are planned. In summary, silica refining can be used to achieve finished oils of excellent quality and stability, while eliminating the troublesome soapstock and water wash streams. Therefore silica refining offers an environmentally sound processing alternative.

Table 1. Silica Refining of Superdegummed Canola

	P ppm	Fe ppm	ChlA ppm	Color Red	Rancimat hrs @ 100°C
Physical Refining					
SD Oil	27.9	0.28	21.90	15.0*	--
Bleached Oil	1.0	<0.04	0.05	6.7	--
Deodorized Oil	1.0	<0.04	0.03	0.5	17.75
Caustic Refining					
SD Oil	27.9	0.28	21.90	15.0*	--
Neutralized Oil	0.7	<0.04	20.60	13.0*	--
Bleached Oil	0.7	<0.04	0.05	2.0	--
Deodorized Oil	<0.25	<0.04	0.05	0.5	18.25
Silica Refining - MPR					
SD Oil	27.9	0.28	21.90	15.0*	--
Silica Refined Oil	<0.25	<0.04	21.20	14.0*	--
Bleached Oil	<0.25	<0.04	0.05	4.7	--
Deodorized Oil	<0.25	<0.04	0.02	0.4	19.50

Notes:

Color measured in AF960 Automatic Tintometer, 5.25" cell

* 1" cell

P, Fe by ICP

Brinkman Rancimat 617

Table 2. Silica Refining of Superdegummed Canola
Tocopherol Levels in RBD Oils

	Tocopherol, (mg/100 g. oil) Total	Alpha	Gamma	Delta	Rancimat hrs @ 100°C
Caustic Refining Oil	38.6	12.4	2.3	23.9	18.25
Physical Refining Oil	35.3	12.1	1.6	21.6	17.75
Silica Refining - MPR	58.4	17.7	6.1	34.6	19.75

Table 3. Silica Refining of Superdegummed Canola
Schaal Oven Test

	Color Red 5.25" cell	Totox 2xPV+AV	Rancimat hrs @ 100°C
Physical Refining			
Fresh	0.5	1.34	17.75
4 Days	0.8	5.30	17.75
8 Days	1.2	6.60	15.50
Caustic Refining	-		
Fresh	0.5	1.99	18.25
4 Days	0.8	6.38	16.50
8 Days	1.0	10.00	14.00
Silica Refining - MPR			
Fresh	0.4	0.79	19.75
4 Days	0.7	4.17	17.25
8 Days	1.0	6.89	15.25

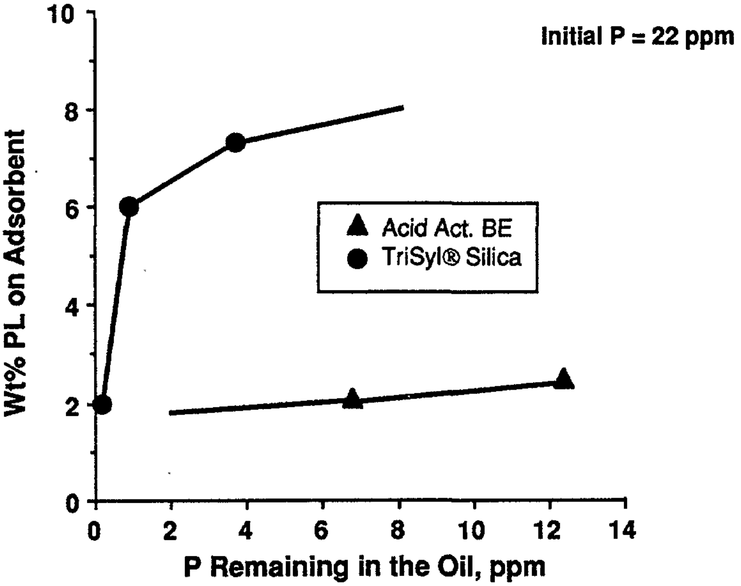

Fig. 1. Phospholipid Capacity Isotherm in Superdegummed Canola

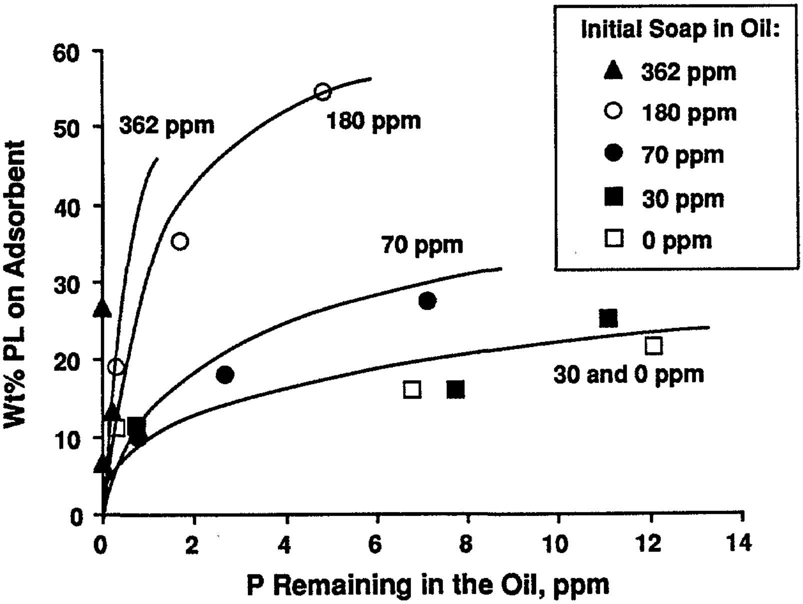

Fig. 2. Phospholipid (PL) Capacity of TriSyl Silica as a Function of Initial Soap Content in the Oil

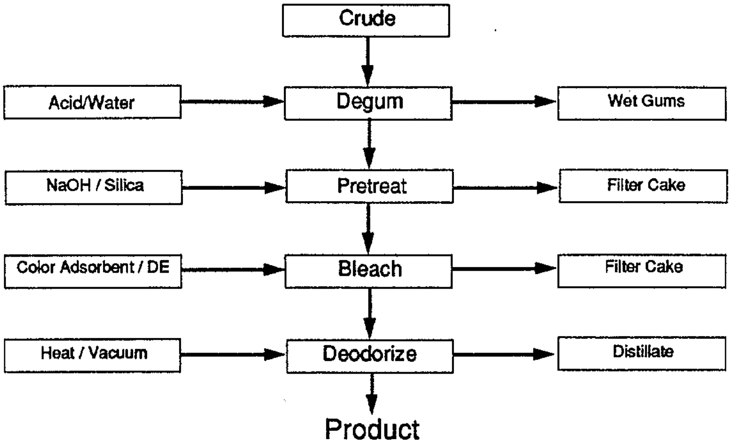

Fig.3. Silica Refining MPR Modified Refining Flowchart

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