CO1978PROD01

THE PROCESSING OF RAPESEED AND ITS PRODUCTS

By Johan G. Wiegand
Union Deutsche Lebensmittelwerke GmbH, Unimills,
Hamburg, Federal Republic Germany

1. Introduction

By way of introduction I have been asked to sketch the progress that has been made in the processing of rapeseed and its products since the 4th International Rapeseed Congress at Gießen in 1974. I shall attempt to do so by outlining the status quo with special reference to novel data, products and processes, in so far as this information has been made available in the literature, and against the background of know-how in my own company.
A number of aspects will no doubt warrant further clarification and I trust that the papers and discussions on the specific topics will contribute to this.

The production of rapeseed appears to have reached a fairly constant level. (Fig.1) Most of the major producing countries in Western Europe have switched or are switching to low or zero-erucic acid varieties a whole range of which with improved yield characteristics and disease resistance have now become available. Whereas Canadian rapeseed is mostly of the summer campestris type European growers traditionally favour the higher yielding winter napus type.

The separation of low and high erucic acid rapeseed and rapeseed oil stocks needs some extra technical equipment and additional analytical control, but basically it gives no problem for the oilmillers.

In most West-European countries rapeseed oil may practically not contain more than 5 % of erucic acid as an edible commodity. This has meanwhile been backed by EEC legislation according to which a 5% upper limit has been specified as from 1979, max. 10 % erucic acid holding for the interim period. For populations in which oils and fats constitute a high proportion of dietary energy the FAO/WHO has generally recommended a reduction of the erucic acid in brassica oils.

Double low, i.e. in respect of erucic acid and glucosinolates, rapeseed varieties like the Canadian "Tower" and "Regent" cultivars (44) have practically not been available up to now in Europe on a commercial scale. It will take another six or seven years until corresponding winter-hardy types suitable for European

FIG. 1

PRODUCTION OF RAPESEED ('000 T)

	1960	1970/71	1971/72	1972/73	1973/74	1975/76	1976/77	1977/78 prel.
GERM. FED. REP.	69	185	228	249	222	199	222	268*
NETHERLANDS	8	22	33	45	41	37	34	30
FRANCE	83	585	650	713	658	532	561	421*
UK	2	8	10	14	31	61	111	140*
DENMARK	13	22	46	50	92	131	81	71
TOTAL EEC	185	829	974	1.080	1.057	964	1.012	933
SWEDEN	61	167	220	284	295	285	244	211*
CZECHOSLOWAKIA	55	63	101	107	117	131	134	120
HUNGARY	3	48	71	52	68	65	60	65
POLAND	147	566	595	430	512	726	980	700
GERMAN DEM. REP.	182	181	197	236	247	364	321	315
TOTAL EUROPE	687	1.912	2.229	2.256	2.378	2.632	2.855	2.477
CANADA	252	1.637	2.155	1.300	1.207	1.749	837	1.776
CHINA	900	1.000	1.050	1.150	1.260	1.350	1.300	1.200
INDIA	1.063	1.975	1.433	1.808	1.704	1.936	1.562	1.800
PAKISTAN	323	269	301	287	292	267	288	
TOTAL WORLD	3.538	7.125	7.500	7.030	7.045	8.185	7.089	7.857

*Low erucic acid varieties

climatic conditions come on-stream. Processing experience to date with double low European varieties being developed, like "Erglu", has been limited to small scale trials.

I should now like to discuss in more detail

- the separation of rapeseed into oil and meal
- the treatment of meal and preparation of protein isolates and concentrates,
- and oil refining.

2. Separation of rapeseed into oil and meal

As a general rule, a 7 - 8 % moisture content in the seed can be regarded as being safe for storage and for minimising processing difficulties. We have not been able to relate processing difficulties specifically to new zero or low erucic acid varieties. It appears that the origin of the seed has a greater influence on processing characteristics than its variety. The origin may in turn relate to the conditions of harvesting, drying, storage and transport. Quite possibly, the distribution of water in the seed, for a given moisture content, as governed by drying and storage conditions before receipt at the oil mill, might be an important factor in the successful selection of further processing parameters.

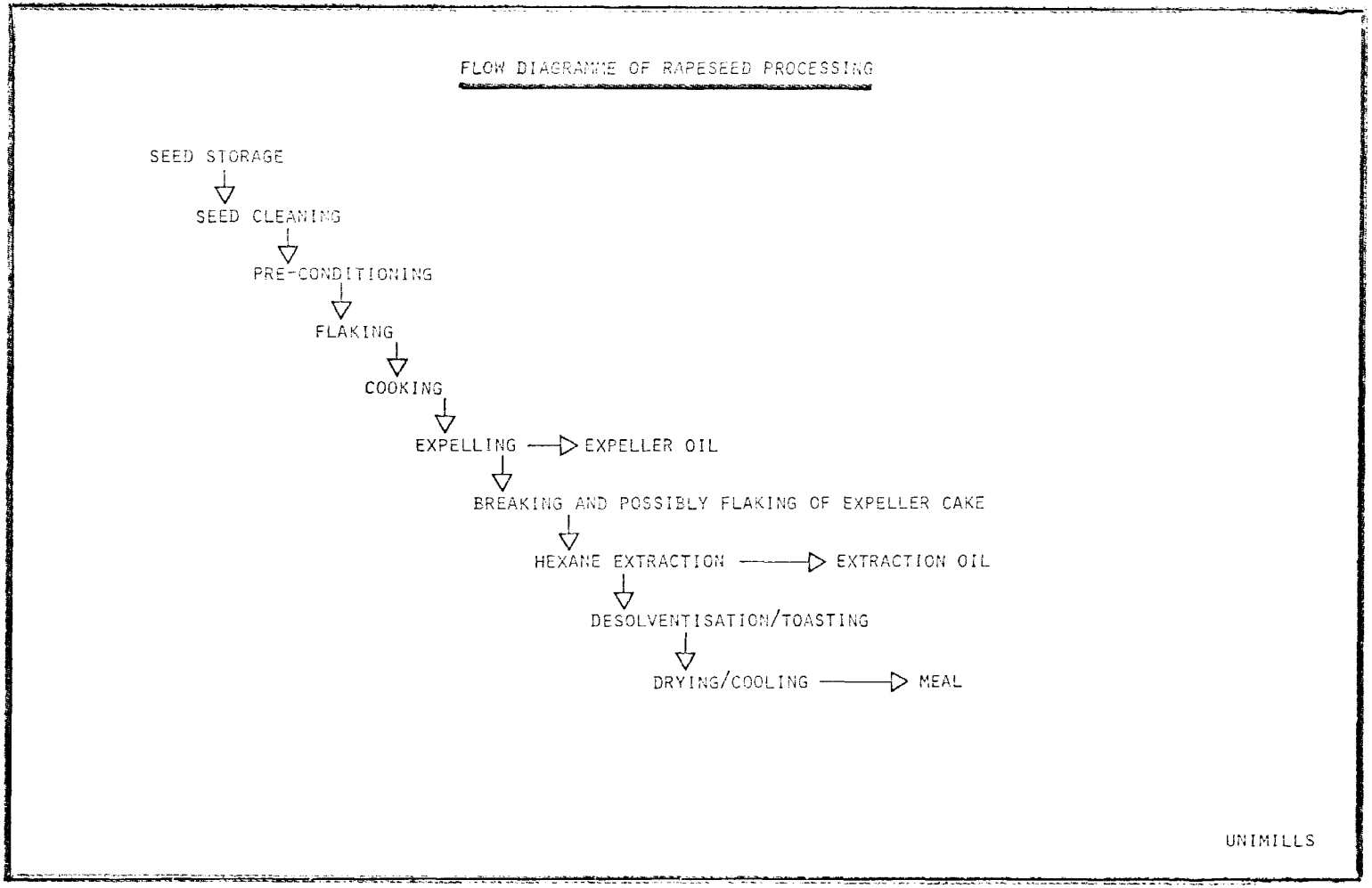
Single stage high pressure expelling has normally gone out of use. To-day the bulk of rapeseed is processed by prepressing and solvent extraction (Fig.2). The basic aim is to produce a meal with a minimum residual oil content at commercially acceptable throughputs without impairing meal and oil quality.

After pre-conditioning of the cleaned seed, to adjust the moisture content (6 - 8%) and temperatures (20 - 40° C), it is rolled to ca. 0.25 - 0.5 mm flake thickness. During flaking a large part of the cell structure is broken down; regarding residual oil content in meal, it is important to prevent seeds escaping comminution.

Subsequent conditioning or "cooking" of the comminuted seed in a stack cooker or in a series of horizontal, cylindrical conditioners ensures optimal expelling, normally done in continuous screw presses. During expelling cell rupture is completed and the oil content is reduced to 16-20%. Residence time, temperature and moisture during cooking have an important influence on expelling and extraction performance and are crucial parameters as far as yield and characteristics of meal and oil are concerned. They require skilful optimisation.

Lipase and lipoxygenase, leading to undesirable hydrolysis and oxidation of the oil, and myrosinase,

Fig. 2


FLOW DIAGRAMME OF RAPESEED PROCESSING
SEED STORAGE
SEED CLEANING
PRE-CONDITIONING
FLAKING
COOKING
EXPELLING
EXPELLER OIL
BREAKING AND POSSIBLY FLAKING OF EXPELLER CAKE
HEXANE EXTRACTION
EXTRACTION OIL
DESOLVENTISATION/TOASTING
DRYING/COOLING
MEAL
UNIMILLS

which hydrolyses glucosinolates into oil-soluble sulphur and nitrogen compounds (4) impairing oil quality, are most active at temperatures between 40 and 70°C. Destruction of these enzyme systems begins at temperatures of 70 - 80°C (5), provided the moisture content is at least 8 - 9 % (44). It is hence important to reach a temperature of at least 80°C in the cooker as quickly as possible and to maintain it for 20 - 30 min. Heating to well beyond 90°C can be detrimental to both oil and meal quality by inducing colour reactions and excessive protein denaturing. Normally, the moisture gradient runs from ca. 9% in the first to 5 - 6 % in the last part of the cooker, which facilitates expeller performance.

One difficulty in elucidating the enzymatic and non-enzymatic decomposition of glucosinolates, particularly at elevated temperatures (33), is the fact that normally sulphur is determined as such and not in the form of the compounds in that it is present.

Extraction of the ground expeller cake with hexane removes the remainder of the oil down to levels of 2 - 4 % in meal. Conventional rapeseed consists for about 17 % of hulls, diminishing the protein content in the meal. Hence there is a principal interest in the development of new varieties which have a yellow, thinner seed coat enabling higher protein contents, and a better appearance of the meal to be reached (44). Canadian efforts in this area seem to be promising (4).

Dehulling of seed by pneumatic attrition or impact followed by air classification and screening suffers from considerable portions of meats adhering to the hulls and therefore still appears to be confined to pilot plant scale (26), (34) - (37).

Efforts are obviously being continued to simplify the processing of rapeseed by eliminating the intermediate expelling stage. One basic approach (8) is to flake the seed down to ca. 0.1 mm to complete cell rupture, and to directly extract these flakes, after having agglomerated them to facilitate percolation and filtering. The agglomeration is done by heating with live steam at ca. 100°C followed by drying and cooling ("crisping") (38) (39) and possibly also reflaking (40). The economics of this "Filtrex" type process in terms of residual fat contents in the meal and in terms of maintenance of flaking rolls have yet to be proved for larger plants; there is also the question of the influence on oil characteristics.

In the "Direx" type process (9) the pre-extracted, hexane-moist material is reflaked or milled (41) before a second extraction, according to the immersion principle, is done. Comminution in the presence of hexane is supposed to facilitate the bursting of oil cells and hence complete extraction of oil. Although the economics

of this process are said to be attractive it still appears to be confined to small scale plants, probably in view of the potential safety hazard involved.

3. Preparation of rapeseed meal, concentrates, and isolates

The toxicity of vinyl oxazolidinethione (VOT) and alkyl isothiocyanates (ITC), degradation products (6) of glucosinolates which are contained in rapeseed up to 10%, is reflected in the limits that have been laid down by the EEC for animal feedstuffs (Fig.3). An additional problem is that the animal organism can contain enzyme systems which can hydrolyze residual thioglucosides in the meal in spite of the myrosinase having been deactivated during processing. The total potential toxicity is apparently also not entirely characterised by the sum of VOT, ITC and glucosinolates since under certain conditions, e.g. in the presence of ferrous salts, glucosinolates can give rise to thioamides and nitriles, the latter being particularly suspect (6) (3).

Breeding of so-called "double zero" rapeseed varieties, like the Canadian "Tower" and the German "Erglu", only containing ca. 1/10 th of the glucosinolates present in conventional varieties, has been an important step towards solving the toxicity and palatability problem of rapeseed meal while simultaneously increasing the protein content by about 3 - 4 %. It will take, however, a number of years until these types are generally on stream. Also, first trials with "Erglu" and "Tower" meal have shown that the residual glucosinolates and their degradation products (ca. 0.10 - 0.15 % VOT and ca. 0.03 - 0.05 % ITC) (44), and possibly also other types of compounds like tannins, sinapine and phytic acid (44), still impair full flexibility of the use of rapeseed meal. Suitable post-treatment of rapeseed meal will therefore continue to play a role. Various biochemical, chemical and physical processes for detoxifying rapeseed meal were reported at Giessen in 1974 (Fig.4).

As far as technical application to meal is concerned, Unimills have, for instance, adopted a process employing the addition of slaked lime to meal at the toasting stage (10). This process guarantees VOT levels of $\leqslant$ 0.3%, corresponding to a detoxification efficiency of 70 - 80%; this type of meal now features in the German feedstuffs directive. Henkel (3) has reported pilot plant studies in which "Erglu"-meal, prepared by direct extraction of short-time conditioned flakes, was improved by autoclaving at ca. 120°C.

Extraction with various aqueous solvent systems to produce concentrates is apparently still confined to semi-technical scale.

Fig. 3

ECC LIMITS FOR ITC AND VOT

CONTAMINANT	FEEDINGSTUFF	MAX. CONTENT IN MG PER KG
ISOTHIOCYANATES (CALC. AS ALLYL-ISOTHIOCYANATE); ITC	RAPESEED EXTRACTION MEAL RAPESEED CAKE	4.000 (0,4 %)
	OTHER RAW MATERIALS FOR FEEDING-STUFFS	100
	COMPLETE MIXED FEEDS FOR CALVES, LAMBS AND KIDS	150
	OTHER COMPLETE MIXED FEEDS FOR COWS SHEEP AND GOATS	1.000
	COMPLETE MIXED FEEDS FOR PIGLETS	150
	OTHER COMPLETE MIXED FEEDS FOR PIGS	500
	COMPLETE MIXED FEEDS FOR POULTRY	500
	OTHER COMPLETE MIXED FEEDS	150
VINYL OXAZOLIDINETHIONE; VOT	COMPLETE MIXED FEEDS FOR LAYING HENS	500
	OTHER COMPLETE MIXED FEEDS FOR POULTRY	1.000

UNIMILLS

RAPESEED DETOXIFICATION TECHNIQUES

- BIOCHEMICAL PROCESSES (ENZYMES) (17)

- CHEMICAL PROCESSES

A) SALTS OF HEAVY METALS (18, 19)
B) PEROXIDES (20)
C) ALKALINE CHEMICALS

- PHYSICAL PROCESSES

A) HEAT (21, 22)
B) EXTRACTION WITH POLAR SOLVENTS
   WATER OR AQUEOUS SOLUTIONS OF ELECTROLYTES (23 - 29)
   ETHANOL (22, 30, 31)
   WATER-ETHANOL-MIXTURES (22, 30, 31)
C) DIFFUSION EXTRACTION METHOD (32)

UNIMILLS

Fig. 4

Such techniques are primarily of interest in connection with the preparation of rapeseed protein products for human consumption. The Karlshamn-Alfa-Laval (11) process, i.e. leaching of dehulled rapeseed followed by drying, flaking and removal of oil, has been reported to give yields of 23 - 28 % of a concentrate containing 65 % protein. Glucosinolate content is reduced to $\leq$0.6 mg/g while VOT plus ITC is $\leq$0.2 mg/g. An additional advantage is that the crude oil has sulphur levels of $\leq$ 2 ppm. El Nockrashy and co-workers (12) have described laboratory trials in which rapeseed meal was extracted with aqueous acetone. VOT and ITC levels are thereby reduced to about 1/10 th of their original values. Only a small part of the lipids and proteins are said to be lost in this process. The same authors have proposed detoxification of rapeseed by autolysis in the presence of myrosinase; a major disadvantage here appears to be the enrichment of sulphur compounds in the oil on subsequent extraction.

Little information has become available in the literature on the preparation of isolates. (13) (14) (15) Basically, all processes rely on the solubilisation of protein with dilute caustic soda followed by acidic precipitation. By skilful selection of the pH isolates practically devoid of VOT and ITC can be obtained. In addition, the sulphur-containing amino acids are concentrated to a level corresponding to the recommended FAO standards for protein of food quality.

4. Refining of oil

The properties of the crude oil are determined by the quality of the seed material (fig.5) and by the processing methods employed. Adverse climatic conditions, field and storage damage can lead to enzymatically induced oxidative and hydrolytical deterioration of the oil. Oxidative deterioration, catalysed by phaeophytin or chlorophyll from immature seeds (cf.fig.5), is normally expressed by such analytical data as ultraviolet absorption at 232 nm, anisidine and peroxide value. Hydrolysis manifests itself by an increase in free fatty acids and often hydratation characteristics of the phosphatide moieties.

Whereas hydrolytical damage of the crude oil can normally be overcome by stronger refining, with corresponding losses in yield, oxidative damage ultimately carries through to the fully refined product.

Flaking of rapeseed normally has little influence on oil quality if the temperature does not exceed ca.30°C. The conditions under which the flakes are cooked before expelling can in principle affect oil quality.

SEED SPECIFICATIONS

SWEDEN 1977	GRADE I	GRADE II	UNACCEPTABLE
APPEARANCE/SMELL	- SUBJECTIVE ASSESSMENT -		
IMPURITIES (%)	MAX. 6	MAX. 10	> 10
MOISTURE (%)	6-8.5	MAX. 6	> 8.5
CHLOROPHYLL IN OIL (PPM)	MAX. 40	MAX. 70	> 70
FREE FATTY ACIDS IN OIL (%)	MAX. 1	MAX. 3	> 3
c 22:1 IN OIL (%)	MAX. 7	MAX. 15	> 15

(CHLOROPHYLL LEVELS >30 PPM ENTAIL PRICE REDUCTIONS; CF. JAOCS, AUGUST 1973)

CANADA	GRADE I	GRADE II	GRADE III
DAMAGED SEEDS (%)	MAX. 3	MAX. 10	MAX. 20
OF WHICH HEATED	MAX. 0,1	MAX. 0,2	MAX. 0,5
MIN. WEIGHT (LB/BUSHEL)	52	50	48
CONSPICUOUS SEED (%) ("DOCKAGE")	MAX. 1	MAX. 1,5	MAX. 2,0
MOISTURE (%)	MAX. 10,5	MAX. 10,5	MAX. 10,5
STONES (%)	MAX. 0,05	MAX. 0,05	MAX. 0,05

(CANADA GRAIN ACT, 1962)

UNIMILLS

Fig. 5 a

SEED SPECIFICATIONS

GERMANY

PROVISIONAL PROPOSAL FOR "SINOLA" - QUALITY

	ECC STANDARD
OIL CONTENT	
C 22:1 CONTENT (%)	MAX. 2
MOISTURE (%)	MAX. 9
FOREIGN MATTER, I.E. $< 1,5$ MM AND $> 3,0$ MM (%)	MAX. 4
HEAT-DAMAGED	NEGATIV

UNIMILLS

Fig. 5 b

There appear to be various effects, not necessarily relating linearly to temperature and moisture, and assessment must also include the corresponding extraction oil. We have indications that at temperatures above 100°C the solubilisation of pigments and sulphur compounds in the oil can increase dramatically.

In a series of production trials the content of chlorophyll and other pigments and sulphur compounds in the expelled oil only increased slightly on increasing expelling temperature from 70 to 90°C (fig.6). The E 232-values for both the expeller and the extraction oil are possibly indicative of slightly increased enzymatic oxidation at the lower cooking temperatures. The phosphatides in the expeller oil are largely of the non-hydratable type. The oil extracted from the expeller cake contains the bulk of the phosphatides and sulphur compounds.

The concentration of phosphatides, free fatty acids, and of oxidised lipids in the extraction oil increases with increasing depth of extraction (fig. 7). In Europe, extraction oil is normally deslimed before it is mixed with the expeller oil. (2).

According to our - as yet limited - experience there appears to be no basic correlation between glucosinolate content of the seed and sulphur content in the oil and lecithin. It has been reported (44), however, that degummed "Tower" oil analysed at less than 1 ppm of sulphur, the hydrogenation behaviour of the neutralised and bleached oil equalling that of soyabean oil; specific processing conditions during expelling and extraction may, however, have contributed to this result.

It is thus a question of striking a proper balance between yield on the oil milling side and effort required on the refining side to reach required raffinate specifications. For a typical 3 bowl-centrifuge refining line for deslimed rapeseed oil the data shown in figure 8 appear to be fairly representative. Phosphoric or citric acid conditioning of the oil prior to caustic soda addition is essential for adequate removal of phosphatides (2). The US-practice of starting from non-deslimed oils is not typical for Europe since a considerable portion of phosphatides and their degradation products finish up in the soap-splitting effluent which is not compatible with European environmental legislation. Neutralisation reduces sulphur and phaeophytin content somewhat (fig.9). Bleaching with up to 1 % of activated earth removes residual traces of soap, hydratable phosphatides, phaeophytin, and oxidised glycerides. Natural earths are less effective. Deodorisation is normally done at

INFLUENCE OF CONDITIONING RAPESEED FLAKES (0,25 - 0,35 MM; CA. 7,5 % MOISTURE) AT DIFFERENT TEMPERATURES ON THE CHARACTERISTICS OF EXPELLER AND EXTRACTION OIL
(UNIMILLS THÖRL, 1977)

	EXPELLER OIL[+++]			EXTRACTION OIL[+++]		
FLAKE CONDITIONING TEMP. (^{o}C)	70	80	90	70	80	90
"FREE FATTY ACIDS" (%)	0,72	0,76	0,77	2,8	3,1	2,0
$E_{232}^{1\ \%}{}_{1\ CM}^{NM}$	2,2	2,0	1,9	3,1	3,0	2,5
$E_{268}^{1\ \%}{}_{1\ CM}^{NM}$	0,21	0,24	0,26	0,48	0,45	0,42
PHAEOPHYTIN (PPM)[+]	22	26	29	35	30	34
$\lesssim$ LECITHIN IN TERMS OF PHOSPHORUS (PPM)	319	315	288	750	540	300
NON-HYDRATABLE "PHOSPHORUS"[++]	303	296	245	335	495	149
LOVIBOND COLOUR(1", RED/BLUE)	3,1/1,2	3,1/1,2	3,2/1,4	4,2/2,3	4,6/2,3	4,8/2,8
SULPHUR (PPM)	2,0	3,8	3,1	14,2	8,5	8,7

\+ CRUDE RAPESEED OIL CONTAINS PREDOMINANTLY PHAEOPHYTIN A AND CHLOROPHYLL, PHAEOPHYTIN IS MEASURED VIA UV-ADSORPTION AT 667 NM IN ETHER SOLUTION.

++ HYDRATION AT $\sim 70^{o}$ WITH ~ 2 % WATER FOR ~ 5 MIN.

+++ EXPELLING WAS DONE ON PRODUCTION SCALE. THE EXPELLER CAKE WAS EXTRACTED IN THE LABORATORY WITH HEXANE AT 60^{o}C.

UNIMILLS

Fig. 6

EFFECT OF EXTRACTION DEPTH ON OIL

PROPERTIES (PILOT PLANT: UNIMILLS EMULSIFIER, 1974)

	"ERGLU"		"LESIRA"	
MEAL				
% OIL IN EXTRACTED MEAL	0,8	2,4	2,2	3,2
OIL				
PHOSPHORUS (PPM)	580	260	-	-
SULPHUR (PPM)	19	23	26	24
CHLOROPHYLL (PPM)	17	16	9,5	10
"FREE FATTY ACIDS (%)	1,1	0,90	0,70	0,65
$E_{232\,NM}^{1\%}{}_{1CM}$	2,4	2,0	2,8	2,1

UNIMILLS

Fig. 7

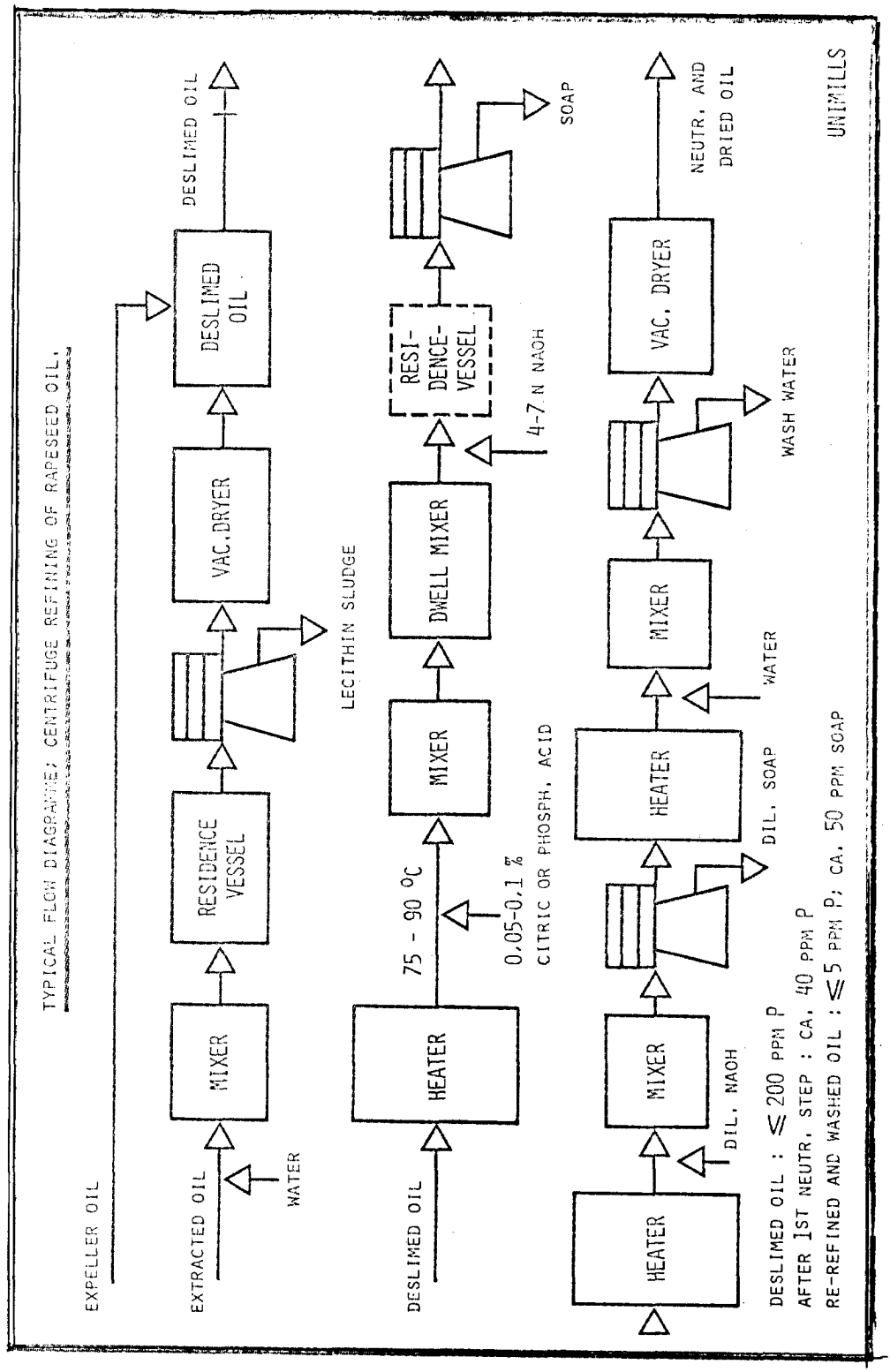

TYPICAL FLOW DIAGRAMME; CENTRIFUGE REFINING OF RAPESEED OIL.
EXPELLER OIL
EXTRACTED OIL
WATER
MIXER
RESIDENCE VESSEL
VAC. DRYER
DESLIMED OIL
DESLIMED OIL
LECITHIN SLUDGE
DESLIMED OIL
HEATER
75 - 90 °C
0,05-0,1 %
CITRIC OR PHOSPH. ACID
MIXER
DWELL MIXER
RESI-DENCE-VESSEL
4-7 N NAOH
SOAP
HEATER
MIXER
DIL. NAOH
HEATER
DIL. SOAP
MIXER
WATER
WASH WATER
VAC. DRYER
NEUTR. AND DRIED OIL
DESLIMED OIL : ≤ 200 PPM P
AFTER 1ST NEUTR. STEP : CA. 40 PPM P
RE-REFINED AND WASHED OIL : ≤ 5 PPM P; CA. 50 PPM SOAP
UNIMILLS

Fig. 8

INFLUENCE OF REFINING ON THE CHARACTERISTICS OF A TYPICAL RAPESEED OIL

$C_{22:1} \leq 2,5$ % (UNIMILLS TYPICAL 1977, PRODUCTION)

	FREE FATTY ACITS (%)	LOVIBOND COLOUR (YELLOW/RED/BLUE)	PHAEOPHYTIN+ (PPM)	PHOSPHORUS (PPM)	SULPHUR++ (PPM)	$E^{1\%}_{1cm}$ 232 NM
CRUDE,DESLIMED OIL	2,4	30/5,0/4,0 [1"]	22 (26)	146	12 (29)	2,1
NEUTRALISED OIL	0,09	30/4,0/2,3 [1"]	18 (19)	2,0	9,4 (14)	2,2
NEUTRALISED AND BLEACHED OIL	0,09	30/6,2/0,7 [5 1/4"]	1 (<0,02)	<1,0	7,7 (11)	2,1
DEODORISED OIL	0,07	11/1,1/ - [5 1/4"]	<0,02 (<0,02)	<1,0	1,8 (1,9)	2,9

\+ DETERMINED VIA THE SPECIFIC ABSORPTIVITY OF PHAEOPHYTIN A (α = 59,0 LG^{-1} CM^{-1}) IN ETHER AT 667 NM

++ DETERMINED VIA CATALYTIC HYDROGENATION WITH RANEY NICKEL, FOLLOWED BY LIBERATION OF H_2S BY ACIDIFICATION AND MEASUREMENT AS METHYLENE BLUE AT 670 NM (CF. FRANZKE ET AL. DIE NAHRUNG, 16.(8), 867 (1972)

( ) THE SULPHUR AND PHAEOPHYTIN VALUES IN BRACKETS ARE FOR ANOTHER BATCH OF RAPESEED OIL

UNIMILLS

Fig. 9

temperatures between 220 - 240°C; besides removal of volatile flavour components and stabilisation of the oil deodorisation significantly reduces the concentration of sulphur compounds.

The criteria applicable in Germany for a refined rapeseed conforming to "Sinola" quality, specifications set up last year by the Central Marketing Institute for Agricultural Products (CMA), are included in figure 10.

An alternative, continuous method of refining is the Zenith process (2). After treatment with phosphoric acid, followed by sludge removal if necessary, the oil is neutralised as droplets rising by gravity through a column of weak lye; water washing is claimed not to be required. The key to the success of this type of process is adequate removal of phosphatides in the first stage.

It has been claimed to be feasible to obtain satisfactory raffinates by adsorptive pre-treatment of crude, deslimed rapeseed oil followed by filtration and combined stripping/deodorisation. Provided the lecithin content in the deslimed oil is sufficiently low and provided sufficient activated earth is used it is apparently possible to obtain oils of satisfactory appearance (44) although one would expect severe fluctuations in organoleptical and oxidative stability, dependent on crude oil quality.

An adequately refined, zero-erucic acid rapeseed oil is comparable in its nutritional (1) (6) (44) and consumer properties to soyabean oil. The levels of linolenic acid in both oils are of the same order and basically determine oxidative and organoleptical properties. Rapeseed mutants with as little as 3.5 % linolenic acid have been reported (7). If such varieties with a significantly reduced linoleic acid and an increased linoleic acid content can be successfully stabilised for various climatic conditions and propagated on an economical basis, the corresponding rapeseed oil would have a decided advantage over soyabean oil. It is occasionally being said that the taste stability and frying behaviour of zero-erucic acid rapeseed oil is inferior to that of high-erucic acid rapeseed oil. We have found no evidence for a direct correlation between erucic acid content and raffinate quality but the linolenic acid content is slightly higher in the new varieties. There appears to be a general trend for oil from summer varieties to be less stable than that from winter varieties (42); this might be connected with the linolenic acid content being somewhat higher in oil from summer varieties (43). Although there appears to be no strict relationship between sulphur content and taste, there are indications that elevated sulphur contents can impair frying odour.

QUALITY SPECIFICATIONS / RAPESEED OIL

	CRUDE, DEGUMMED OIL (SWEDEN)	CRUDE, DEGUMMED OIL (UNILEVER PROVISIONAL FOR PREMIUM PRODUCTS)	FULLY REFINED OIL ("SINOLA"-QUALITY, GERMANY)
ANISIDINE VALUE	MAX. 2,0 - 2,5	-	-
PEROXIDE VALUE (ME./KG)	MAX. 1,0 - 1,4	-	-
OXIDATION VALUE (2X POV + AV)	MAX. 6,0	-	-
$E_{232\,NM}^{1\,\%}$ $1\,CM$	-	MAX. 3,0	-
FREE FATTY ACIDS (%)	MAX. 1,3	MAX. 1,5	-
CHLOROPHYLL (PPM)	MAX. 20+	MAX. 30	NEGATIVE
FE (PPM)	MAX. 2,0	-	-
CU (PPM)	MAX. 0,05	-	-
SULPHUR (PPM)	-	MAX. 34	MAX. 5
PHOSPHORUS (PPM)	200 - 300	MAX.200	-
$C_{22:1}$ (%)	-	MAX. 5	MAX. 4
CLOUD TEST ($0^{o}C$/5 1/2 H)	-	-	NEGATIVE
ADMIXTURE WITH OTHER OILS(%)	-	MAX. 2,0	MAX. 2,0
TASTE STABILITY	-	-	MIN. 8 WEEKS/DARK
MATERIAL VOLATILE AT 105^{o} (%)	0,15	MAX. 0,25	MAX. 0,2
INSOLUBLE IMPURITIES (%)	0,02		MAX. 0,05

+ COMPARE J.Å.H. DAHLÉN, JAOCS, 50,312 A (1973)

UNIMILLS

Fig. 10

Sulphur contents in neutralised and bleached oils do, of course, increase catalyst consumption during hydrogenation.

Although the composition of the major components of rapeseed lecithin closely resembles that of soyalecithin rapeseed licithin is inferior in colour, flavour and general appearance. One reason for this is presumably to be sought in its high content of sulphur compounds (42) which appears to be independent of the glucosinolate content of the seed material. There has been a proposal to improve the colour of rapeseed lecithin by treating miscella with activated earth (43) but large scale application of this method has not been reported.

5. Literature

1) R.O. Vles et al, Fette - Seifen - Anstrichmittel, 78, 128 (1976)
2) B. Braae, JAOCS, 53, 353 (1976)
3) B. Henkel and B. Brak, paper presented at the DGF congress in Würzburg in September 1977
4) Compare K. Downey, Chem.or Ind., May '76
5) R. Ohlson, JAOCS, 53, 299 (1976)
6) A. Seher, Deutsche Lebensmittel-Rundschau, 73, 69 (1977)
7) G.Z. Rakow, Pflanzenzucht, 69, 62 (1973)
8) J. Furman et al, JAOCS, 36, 454 (1959)
9) JAOCS, 49, 364 A (1972)
10) E.W. Trautschold, German Offenlegungsschrift 2704743
11) K. Anjou, R. Ohlson et al. Proceedings 4th International rapeseed Conference, Gießen, 4 - 8 June 1974, p. 659
12) A.S. EL Nockrashy et al., Fette - Seifen - Anstrichmittel 78, 306 (1976)
13) A.S. EL Nockrashy, Fette - Seifen - Anstrichmittel 78, 311 (76)
14) F.W. Sosulski, A. Bakal, Canad.Inst.Food Sci.Technol. J., 2, 28 (1969)
15) A. Rutkowski, J. Korolczuk, "Proceedings, 4th Internat. Rapeseed Conference, Gießen 1974, p. 637
17) T. Staron, Proceeding of the Intern.Conference on the Science, Technology and Marketing of Rapessed and Rapeseed Products, Ste. Adèle, Québec, 1970, p. 321
18) C.G. Youngs, A.S. Berlin, Canad.J.Chem.45, 1801 (1967)
19) J.M. Bell et al., Canadian Patent 839653, 1970
20) G.H. Anderson et al., J. Nutrit. 105, 317 (1975)
21) R.J. Belzile et al., Canad.J. Animal Sci., 43, 169(63)
22) A. Rutkowski, Proceedings of the International Conf. on the Science, Technology and Marketing of Rapeseed and Rapeseed Products, Ste. Adèle, Québec, 1970, p. 496
23) H. Kozlowska et al., Canad.Inst.Food Sci.Technol.J., 5, 149 (1972)
24) R.S. Bhatty, F.W.Sosulski, JAOCS, 49, 346 (1972)
25) F.W. Sosulski et al, Canad.Inst.Food Sci.Technol.J., 5, 101 (1972)
26) K.E. Eapen et al., JAOCS, 46, 52 (1969)
27) N.W.Tape et al., Canad.Inst.Food Sci.Technol.J.,3, 78 (1970)
28) D. Ballester et al.,J.Sci.Food Agric., 21, 143 (1970)
29) D. Ballester et al.,J.Sci.Food Agric., 24, 127 (1973)
30) C.H. van Etten et al.,J.Sci. Food Agric., 22, 653 (1971)

31) A.B. Afzalpurkar et al., Proceedings 4th International Rapeseed Conference, Gießen 1974, p. 609
32) H. Kozlowska et al., Proceedings 4th International Rapeseed Conference, Gießen, 1974, p. 651
33) K.E. Eapen et al, JAOCS, 45, 194 (1968)
34) C.E.T.I.O.M. Inform. Techn. No. 32 (1973)
35) Proceedings 4th Int. Rapeseed Congress, Gießen, 633 (1974)
36) Canadian patent 973526 (1975)
37) Publ. No. 35 Research Committee Rapeseed Ass. of Can.,1971
38) Dutch patent 7302358
39) Seifen - Öle - Fette - Wachse, 99, 358 (1973)
40) JAOCS, 54, 481 A (1977)
41) German patent 2346093
42) Verbal communication, J. Dahlén, 1977
43) L.-Å. Appelquist & R. Ohlson, Rapeseed, Elseview, 1972
44) Rapeseed Association of Canada, Pub. No. 45, Rapeseed oil, meal and by-product utilisation, Proceedings of a Symposium, March 22-23, 1977, Vancouver, BC