Rapeseed Oil Quality

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Summary

Against a background of increasing production of rapeseed in the EEC and U.K. the quality of the oil is discussed, from the point of view of the oil refiner and the food manufacturer, to highlight where improvements might be made to increase utilisation of rapeseed oil as a food ingredient.

In economic terms refining costs would be reduced if the content of phosphatides, sulphur compounds and chlorophyll in crude oils were lower. In the food application area constraints on usage lie mainly in fatty acid composition and, in some applications, flavour. Desirable objectives would be to increase polyunsaturated content and to reduce linolenic acid content.

1. Introduction

The price of rapeseed oil is at least 5 times the price of rapeseed meal and, since the seed contains about 40 % oil, the oil represents over 75 % of the seed value. Oil quality is therefore a very important aspect of crop disposal.

I propose to look at rapeseed oil from the viewpoint of the U.K. processor, more particularly, the refiner, to highlight aspects of oil quality which provide technical and economic obstacles to the faster growth of usage of the oil and to indicate broad objectives for the future.

2. Production and Consumption in the E.E.C.

Before discussing specific aspects of quality it is worth reviewing the background of increasing levels of production and consumption of oil in the EEC. Up to the end of 1983 increase in consumption had matched production increases with exports of oil fairly static. However 1984 saw a dramatic rise in production in the EEC of nearly 40 % (U.K. production was up by 60 %) with the danger of production outstripping local demand.

Some statistics and projections will clarify the picture. Figure 1 shows the growth of rapeseed production (expressed as oil) in the EEC and its main producing members. The EEC probably achieved second place, after China, in world production in 1984 and the U.K. now lies fifth with nearly 1 million tonnes rapeseed.

Figure 2 is a projection of historic EEC production and utilization from 1975. Production refers to the crop year and is slightly out of phase with (ahead of) the usage which refers to calendar year. The projection does not take account of recent proposals of the EEC Commission to phase out support for single zero rapeseed and to support only the double low type; this is likely to put some brake on the expansion due to lower crop yields.

The EEC Commission in their Farm Price Proposals for 1985/86, Green Europe Newsflash (28), showed forecasts of rapeseed production and oil utilization in 1990. These are shown in Figure 2 but the oil utilization figure seems very conservative against the historical figures.

Figure 3 shows a similar projection for the U.K. but here it was only in 1984 that rapeseed production exceeded the demand for oil.

Usage of rapeseed oil as a percentage of vegetable oil usage for 1984 is shown in Table 1.

Table 1 – Usage of rapeseed oil as a percentage of vegetable oils used in 1983

EEC	16%
U.K.	29%
Germany	20%
Netherlands	13%
France	10%
Italy	8%
Canada	52%

The U.K. is leading the EEC in rapeseed oil consumption and there is evidently room for further increase in other countries.

Both France and Italy were at one time the major users of rapeseed oil (Figure 4) but usage fell dramatically after the erucic acid scare and has never recovered. Legislative limits in France for linolenic acid levels in cooking oils have not helped. If these two countries were to recover to the 1972 peak levels of use they could absorb a further 220,000 tonnes rapeseed oil.

In order to sustain the rapid growth in consumption of rapeseed oil in Europe attention will need to be given to a number of technical and economic factors that affect demand.

3. Crushing

Most EEC rapeseed is of the winter type (Brassica napus) with relatively high glucosinolate content. The double-low spring-type grown in Denmark has presented processing problems to European crushers in low throughout rates and high residual oil content. This is suspected to be due to mucilage in the seed which was experienced in Canada some years ago. Canadian seed presents much less problem. With EEC concentration in the future on double low seed there is a need for this seed to show improved processing characteristics over the Danish type.

4. Effects of Crude Oil Quality on Refining and Processing

High levels of unripe seeds and chlorophyll can result in green refined oils unless increased levels of bleaching earth are used in refining; this makes processing more expensive. Unlike Canada and Sweden there are no EEC specifications to cover green seeds or chlorophyll content of seeds going to the seed crusher. For a good deodorised oil chlorophyll contents of the refined, bleached oil entering the deodoriser need to be less than 100 p.p.b.

High free fatty acid content in the crude oil causes high refining losses and is the result of, for example, damaged seed, sprouted seed, poor storage or overheating in storage and high admixture. Bad storage can also lead to poor quality oils of dark colour due to oxidation. Phosphatides and sulphur compounds which are natural components of the seed also present problems in refining and oil quality. High phosphatide content in crude oil means a lower yield of refined oil ultimately, whether the phosphatides are removed by prior degumming or during the refining process. For good quality edible oil the phosphorus content needs to be no more than about 5 p.p.m. before deodorisation. Physical refining, which is the most economic route, requires phosphorus levels to be reduced to less than 50 p.p.m., and probably less than 30 p.p.m., prior to the bleaching stage; hence the use of superdegumming processes. Efficiency of degumming depends on the ratio of hydratable to non-hydratable phosphatides and the latter increases with age of the seed and poor storage.

Sulphur compounds are present in the oil as a result of breakdown of glucosinolates during seed processing. They cause poisoning of nickel hydrogenation catalysts and the level ideally should be below 5 p.p.m. Catalyst poisoning results in slow hydrogenation, low production throughout and higher usage of catalyst, all of which increase processing costs. The poisoned catalyst also results in increased formation of high melting trans fatty acids and limits the extent to which the solid fat content and melting properties of the hydrogenated fat can be varied. It also seems possible that sulphur compounds play part in the characteristic odour of rapeseed oil, particularly frying odour.

The poisoning effect of volatile sulphur compounds can be reduced if the oil is subjected to deodorisation before hydrogenation. This is sometimes practised but is expensive. Ideally lower sulphur content in the crude oil is required or more economic ways of removing it.

5. Specifications for Rapeseed Oil

Recently proposals for specifications for crude rapeseed oil have been developed by VERNOF, the Dutch refiners' association, and SCOPA, the U.K. association, and Canada has announced new standards as shown in Table 2.

It has not been general practice in Europe to degum the crude oil but, with more experience, the maximum level of phosphorus is likely to be reduced. The European maximum of 5 % erucic acid probably arises from the 5 % limit imposed by EEC intervention standards and food legislation. In practice, in the U.K., erucic acid content is around 1 % and does not exceed 2 % and this probably applies to most EEC oil. So there are grounds for reducing this level to the new Canadian level which now matches the level recently imposed by the FDA in the USA for GRAS status. It is debatable whether limits of chlorophyll can be applied to crude oils unless at the same time specifications for seed delivered to the crusher exclude high levels of immature seed. This does not happen in the EEC at present.

Typical figures for crude rapeseed oil from our factory are given in Table 3.

Table 2 – Specifications for Rapeseed Oil

	Crude		Crude degummed			Super degummed
	VERNOF	Canada	VERNOF	SCOPA	Canada	Canada
F.F.A. (as oleic) % max	2.0	1.0	1.75	2.0	1.0	1.0
Moisture and impurities, % max	0.5	0.5	0.4	0.5	0.3	0.3
Phosphorus, ppm max	900	-	300	300	200	50
Erucic acid, % max	5	2	5	5	2	2
Chlorophyll ppm max	25	25	25	-	25	25
Sulphur ppm max	-	15	-	-	10	10

Table 3 – Typical characteristics of U.K. Rapeseed Oil

FFA	0.9%	
Phosphorus p.p.m	450	(300 - 600)
Chlorophyll p.p.m	10	
Sulphur p.p.m	16	
Fatty acids:		
Erucic	trace - 1.0%	
Linoleic	20 - 22%	
Linolenic	9.0 - 10.5%	
Palmitic	4 - 5%	

6. Use of Rapeseed Oil in Foods

The usage of rapeseed oil as a food fat, in the U.K. and Canada, is compared in Figure 5. The areas in the diagram represent percentages of total refined oil usage ; soya oil is also shown since this is the main competitor to rapeseed oil. Apart from its straight forward use as a cooking oil for domestic and catering purposes, rapeseed oil is being increasingly used by the food manufacturing industry but there are some constraints on more rapid expansion.

The major use of refined oils is in margarine which represents over 30 % of the U.K. refined oil market. Soft margarines, using higher levels of liquid oils, have been taking an increasing market share. Figure 6 shows that usage of rapeseed oil has increased to around 15 % by displacing soya oil. High usage (40 %) of cheap fish oils in margarine in the U.K., compared with other countries, places some limit on its expansion but another factor is its moderate content of polyunsaturated fatty acids of around 30 %. High polyunsaturated (minimum 45 %) margarines are becoming more popular and current rapeseed oil is unsuitable.

Compound fats, about 15 % of the refined oil market, include bakery fats and solid cooking fats and now use rapeseed oil as the main liquid oil ingredient with very little soya oil.

The main constraints on rapeseed oil are related to fatty acid composition and flavour. As already mentioned it is unsuitable for foods with high PUFA claims, yet this is a growing market due to increasing nutritional awareness on the part of the consumer. It explains why usage in margarine now seems to be levelling out. Appreciable increase in polyunsaturated content through seed breeding would overcome this disadvantage.

Linolenic acid content, at 9-10 %, is somewhat higher than in soya oil. It is a major source of oxidative rancidity and in some food applications, such as industrial frying, needs to be limited to 2-3 %. It is undoubtedly also an important factor in the low consumption in France where there is a limit of 3 % in oils retailed for cooking purposes. Reduction of linolenic acid content provides another objective for seed breeding.

Although less important, the very low palmitic acid (C16) content of rapeseed oil prevents the use of very high levels of the hydrogenated oil and, for example, the production of 100 % rapeseed based margarines and biscuit dough fats. The very high content of C18 acids makes the hydrogenated oil liable to polymorphic changes after processing. Polymorphism is the property by which fatty triglycerides can exist in several different crystallise forms, some more stable than others. If, initial crystallisation is in an unstable form, this can change over several weeks to a more stable form, resulting in development of fat bloom on biscuits and granular texture in margarine. Currently it is overcome by limiting the level of incorporation of hydrogenated rapeseed oil and blending with other fats. An increase in palmitic acid content to around 12 % founding soya oil would considerably lessen this problem.

As mentioned previously the catalyst poisoning effect of sulphur compounds restricts the degree to which hydrogenated rapeseed oil can be tailored to suit specific end use applications.

Sulphur compounds are also possibly one of the factors in flavour problems. Rapeseed oil has its own characteristic flavour and cooking odour. The U.K. consumer has become attuned to accept this flavour in domestic cooking but there is resistance in some industrial frying operations. Some particularly flavour-sensitive food areas resist hydrogenated rapeseed oil, for example, ice cream and filled milks, where hydrogenated soyabean oil is acceptable to some manufacturers. Whether the problem is more concerned with sulphur compounds, or with the reversion flavours of particular isomers of unsaturated acids peculiar to hydrogenated rapeseed oil, is uncertain.

7. Health Aspects

Finally it is worth mentioning health aspects. The erucic acid problem has been left far behind and current European rapeseed oil should be able to meet the recent FDA requirement of less than 2 % erucic acid. World wide pronouncements by medical committees have generally been critical of high levels of saturated fat consumption and favoured polyunsaturates and consumers are increasing consumption of liquid vegetable oils.

In the U.K. the recent COMA report on diet and cardiovascular disease has recommended reduction in saturated fat consumption, coupled with labelling of most foods with their saturated fat content, but, in addition, in the case of retail fats, it is proposed that trans fatty acid content be included under the heading 'saturated fatty acids'. Although rapeseed oil is the lowest in saturated content of any of the common oils, the tendency of the hydrogenated oil to contain more trans acids (due to sulphur compounds) than other equivalent oils must raise some concern and provide pressure to reduce sulphur levels.

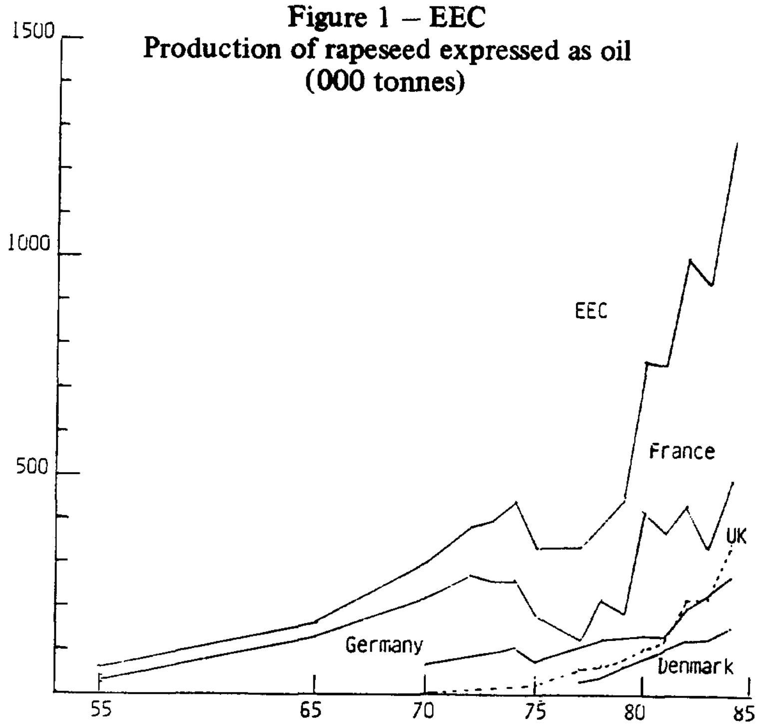

Figure 1 – EEC
Production of rapeseed expressed as oil
(000 tonnes)

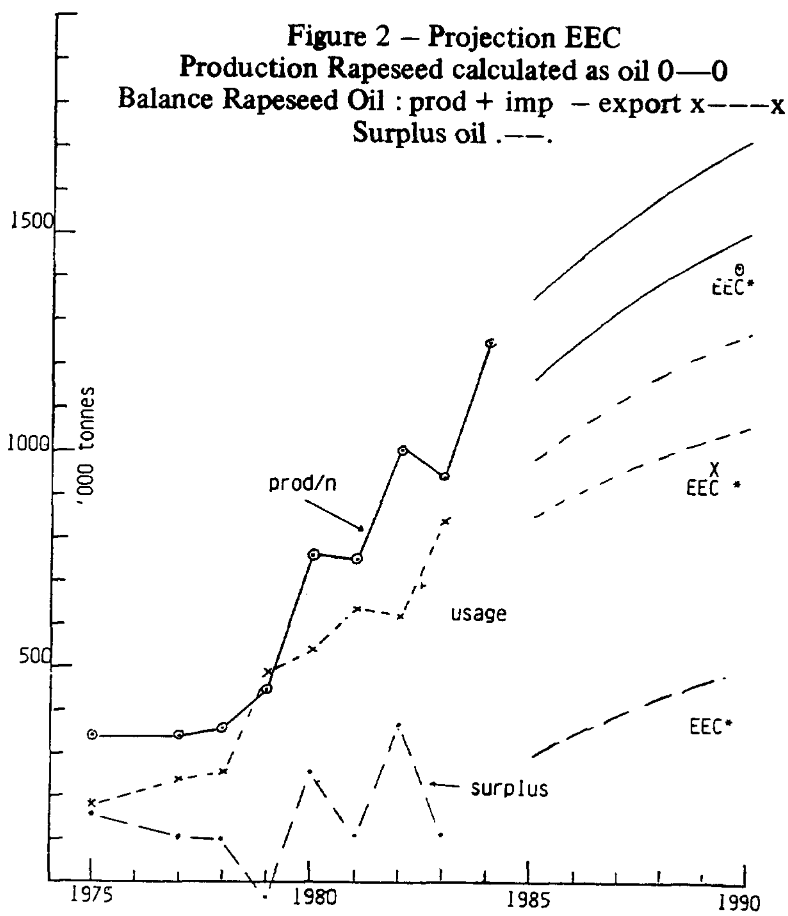

Figure 2 – Projection EEC
Production Rapeseed calculated as oil 0—0
Balance Rapeseed Oil : prod + imp – export x---x
Surplus oil .—.

* EEC Commission forecasts - Green Europe 1985 (28)

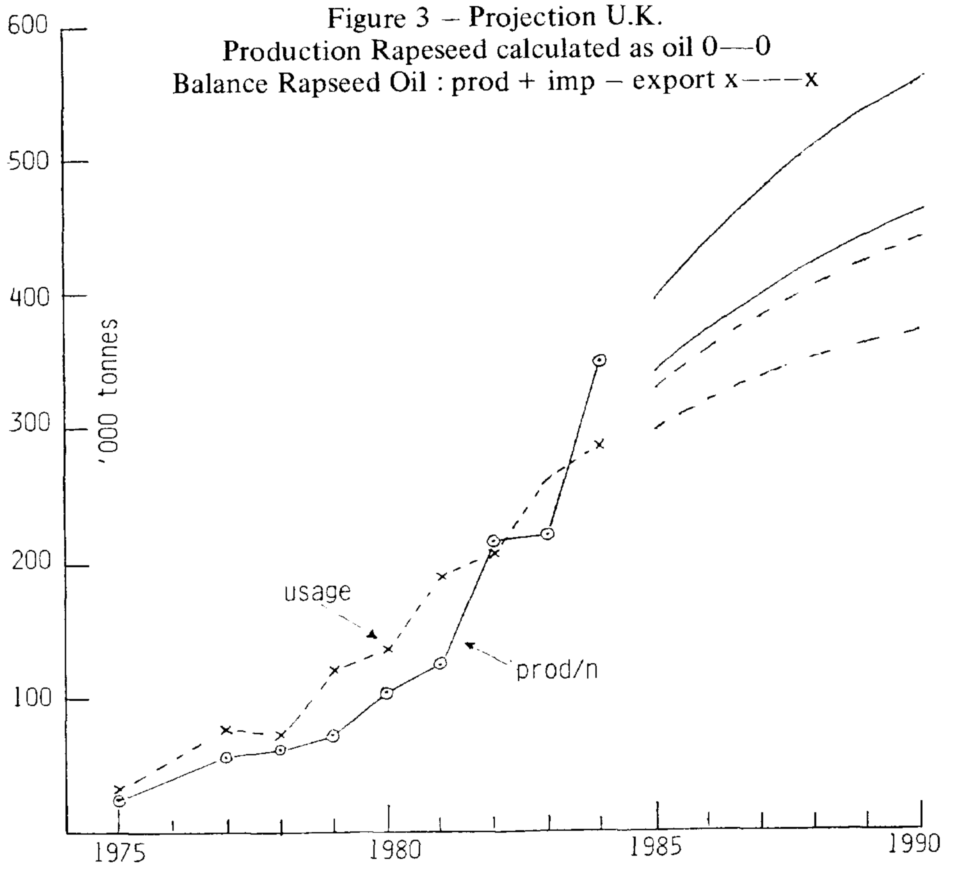

Figure 3 – Projection U.K.
Production Rapeseed calculated as oil 0—0
Balance Rapseed Oil : prod + imp – export x– – –x

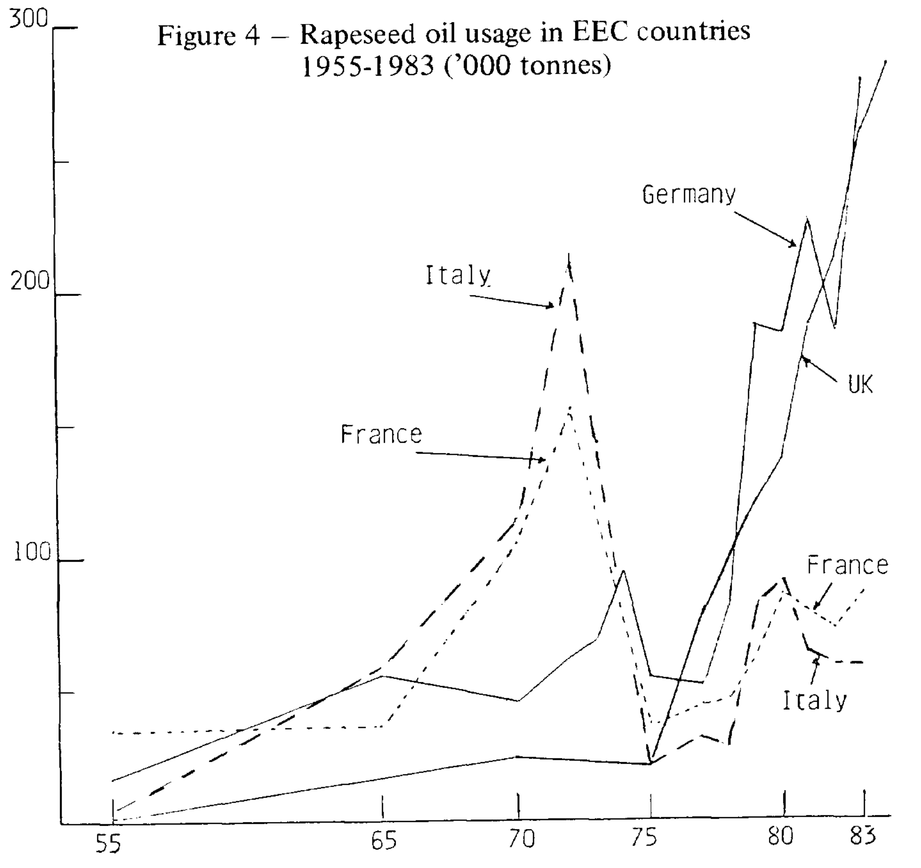

Figure 4 – Rapeseed oil usage in EEC countries
1955-1983 ('000 tonnes)

Figure 5 – Disposal of soyabean and rapeseed oil in food products 1983

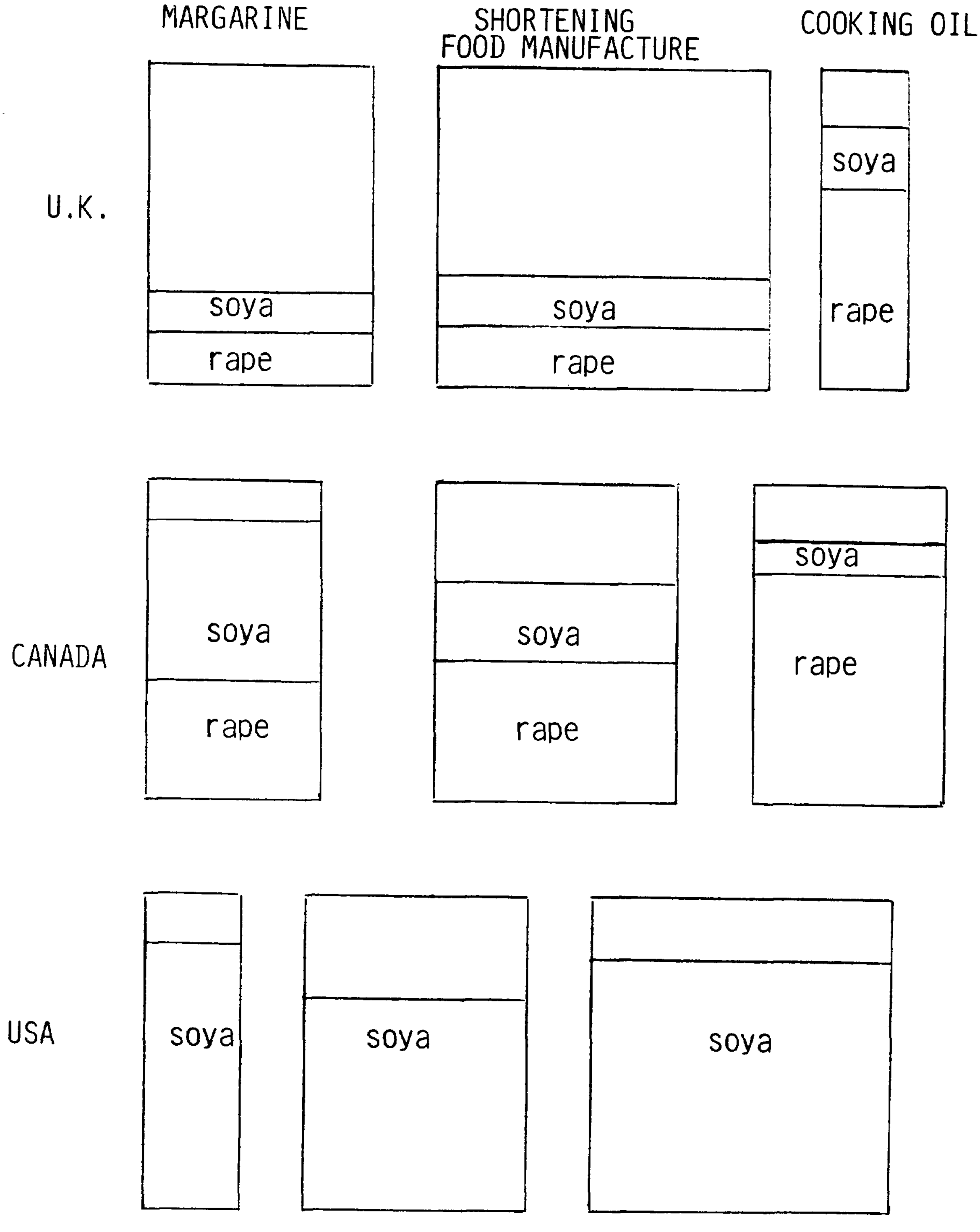

Figure 6 – Use of soyabean and rapeseed oils U.K. %