Rapeseed Oil

J.S.R. OHLSON, Research Laboratory, AB Karlshamns Oljefabriker, S-292 00 Karlshamn, Sweden

ABSTRACT

Rapeseed and oil production are discussed. Properties of the oil are described as they relate to uses in food or industrial applications.

INTRODUCTION

Rapeseed and mustard seed in different forms have been grown in India and China for thousands of years. They came to Europe in the 15th century. The cultivation has increased, particularly since World War II. Rapeseed was introduced to Canada in the 1950s and there it has become a Cinderella crop.

PRODUCTION STATISTICS

Today, rapeseed ranks fifth among the oilseeds of the world. Cultivation of the plant for oilseed production is almost entirely confined to the temperate and warm temperate zones. Rape thrives best in rich soil in a cool, moist climate. During the 1960s, the production of rapeseed increased from 3.5 to 6.6 megatons (Mt). The only oilseeds to show greater increases were soybeans and sunflower. In 1978, it was up to 10.7 Mt. In 1982/83, it is expected to reach 13.3 Mt. The world oil production is shown in Table I. About 50% of the world rapeseed oil production is still of the high erucic acid type (China, India, East Europe).

TABLE I

World Production of Oilseeds (1,000 tons)

Oilseed	1978/79	1981/82	1982/83 (estimated)
Soybeans	77,381	87,313	95,075
Cottonseed	23,954	27,766	25,566
Peanuts	17,636	18,709	18,699
Sunflower seed	12,902	14,268	15,978
Rapeseed	10,709	12,503	13,291
Flaxseed	2,415	2,086	2,230
Copra	4,379	4,842	4,988
Palm kernel	1,348	1,688	1,772

DEFINITION

(High erucic acid) edible rapeseed oil has been defined by the Codex Alimentarius Fats and Oils Committee as an oil having > 5% (m/m) of erucic acid.

The International Organization for Standardization (ISO), at its meeting in 1982, set the following specification for seeds with high erucic acid content intended for the manufacture of industrial oils: minimum 36% oil content (hexane extract) determined on the product as received, expressed in relation to a moisture content of 9% and an impurities content of 2%, % (m/m); maximum 2% acidity of the oil extract, expressed as oleic acid; and minimum 40% erucic acid content as a percentage of the total fatty acid in the oil extract.

COMPOSITION OF THE OIL

The characteristics and distribution of fatty acids in rapeseed triglycerides, which constitute 95-98% of the commercial oil, have been the subject of several investigations. Oil obtained from the high erucic acid (HEAR) cultivars is reported to contain 61% of triglycerides with 62 carbon atoms in the fatty acid chains (mono-C18:1, mono-C18:2 or mono-C18:3 di-C22:1 glycerides), 17% of triglycerides with carbon number of 60, and 6% with carbon numbers of 58 and 56.

Early studies using pancreatic lipase hydrolysis to determine the fatty acid structure of unfractionated HEAR oils demonstrated that the saturated acids and long chain mono- and diunsaturated acids (C20-C24) are esterified mainly in the external positions of the triglycerides. Unsaturated C18 fatty acids were initially laid down in the 2-position of the triglycerides.

Some identity characteristics for high erucic acid oil from the Codex-standard are given in Table II.

SPECIFIC PROCESSING CONDITIONS

In general, high erucic acid oil is processed in the same way and in the same equipment as the low erucic acid oil. One exception is the pungent oil produced in, e.g., India in local so-called ghanis mostly driven by bullocks.

FUNCTIONAL PROPERTIES AND USES FOR RAPESEED OIL

The major part of high erucic acid rapeseed/mustard seed oil is used for food in, e.g., China, India and East European countries.

There are some problems in crystallization of low erucic acid oil in, e.g., margarine production. In a series of slides there are marked differences in the crystallization behavior of rapeseed oils with different contents of erucic acid from 4% to 50% erucic acid (1).

As this conference should also focus on the future, and a future for high erucic acid rapeseed oil will be in the non-edible area, I am going to give some information on this.

Specific uses of rapeseed oil are based on its content of long-chain molecules or molecules with double bonds. In the past, rapeseed oil was used for illumination purposes, and mustard seed oil has been used as a fuel oil. Increased oil prices and vulnerability of the mineral oil supply have led to a large number of trials to use vegetable oils including rapeseed oil as a motor fuel. In Sweden, tractors can be driven on 50:50 RSO:mineral oil mixture with no changes in effect or other problems.

The rapeseed oil used for industrial products is usually refined. Certain modifications of properties can also be achieved, e.g., by blowing. This process has long been practiced to increase viscosity and consists of passing a stream of air through the heated oil. A blown rapeseed oil is appreciably soluble in paraffins, and the solubility varies

TABLE II

Identity Characteristics for High Erucic Acid Rapeseed Oil

Relative density (20 C/water at 20 C)	0.910-0.920
Refractive index (nD 40 C)	1.465-1.469
Saponification value (mg KOH/g oil)	168-187
Iodine value (WIJS)	94-120
Crismer value	71- 85
Unsaponifiable matter	Not more than 20 g/kg
Brassicasterol	Not less than 5% of total sterols
Erucic acid	More than 5% (m/m) of the component fatty acids

inversely with the initial iodine value as well as with the extent of blowing.

Rapeseed oil is traditionally used as a lubricant for metal surfaces, but although it has very favorable lubricating properties its use solely for this purpose has been rather limited during the last decades. Changes in industrial techniques and the availability of synthetic derivatives have caused this decline. Rapeseed oil was used to lubricate steam locomotives, but other mixtures are now used.

Mineral oil prices and the deleterious effects of the oil and of its additives on the environment have made it possible to introduce, in Sweden, a cutting oil based exclusively on vegetable oil products.

An exclusive use of fatty oils is exceptional today, but compounded oils of fatty and mineral oils are more commonly used. Actually, the fatty oil orients itself on the metal surface and the coefficient of friction of fatty oils is generally lower than that of mineral oils.

Quenching of metals is the process of withdrawing heat from metal rapidly to obtain a required structure. Rapeseed oil is used as an additive in quenching oils, because it increases the cooling rate.

Sulfated rapeseed oil alcohols (18-22 carbon atoms) have shown very good foam and detergent properties, and are used for the preparation of washing compounds. Experiments with the use of rapeseed oil as plasticizer and stabilizer in polyvinylchloride have been described.

USES FOR RAPESEED FATTY ACIDS

Erucic acid with its 22 carbon atoms and a double bond in position 13, is the fatty acid of particular interest.

On account of its special properties, erucic acid (*cis*-13-docosenoic acid) is used as sodium salt in hot water detergents, and in water-repelling agents, and the corresponding amine as corrosive preventive.

Certain long-chain fatty amides of erucic acid and rapeseed oil fatty acids have proved to be good plasticizers for vinylchloride resins. The use of ozone to effect oxidative cleavage of an unsaturated fatty acid is common. Ozonolysis of erucic acid yields pelargonic and brassylic acids.

There is a good demand from industry for both of these products. Pelargonic acid is already industrially available as a cleavage product from the ozonolysis of oleic acid. Widespread use of this 9-carbon monobasic acid is reported in the following fields: plasticizers, alkyl resins, vinyl stabilizers, hydrotropic salts, pharmaceuticals, synthetic flavors and odors, flotation agents, insect repellents, and jet engine lubricants. Pelargonic acid is applied primarily in the form of esters, amine condensates and metallic soaps.

Another intriguing possibility is the production of new nylons from brassylic acid. The monomer for nylon 13, 13-aminotridecanoic acid, has been synthesized by several methods from erucic acid, methyl erucate and eruconitrile, all of which are plentiful chemical products. The structures of nylon 13 and nylon 1313 indicate that they should be tough and resistant to abrasion. Due to their low water absorption, they should resist water better than other nylons and they melt at lower temperatures. The low melting points enable nylon 13 to be treated at lower temperatures than normal nylons, and this is a great advantage as nylons are very sensitive to oxidation in air. They should also be easier to mold or extrude to form rods, films and filaments.

The erucic acid is an interesting molecule as starting material for chemical synthesis and in the future we will see many more products on the market.

FUTURE

Finally a few words about the future. It seems likely that world rapeseed production will continue to grow. The main reason for this increase is that antinutritional components can be eliminated, which will make rapeseed meal an excellent feed even for monogastric animals. World production in 1985 may reach 15 Mt and 20 Mt in 1991/92. The main increases will be in China, India, the USSR and the EEC (2).

REFERENCES

1. Ohlson, R., in Dietary Fats and Health, Monograph 10, AOCS, Champaign, IL (under publication).
2. Mielke, S., Oil World, June:171 (1982).