TECHNOLOGICAL ADVANCES IN IMPROVED AND ALTERNATIVE SOURCES OF LIPIDS

Edited by
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Preface

Lipids are very important both as components of human nutrition and in applications such as the chemical, cosmetics and food industries. At present the world oil supply depends on conventional sources and changes in the political and economical map of the world may mean consumer demand will surpass supplies. In developed nations consumer preferences due to nutrition and health factors have also created a need to produce new types of oil.

Many nations lack the power to purchase fats and oil due to shortages in hard currency. These nations have a vast number of plants that can be developed and used in extracting oil for home use and for sale as cash crops. Also, a vast amount of waste from food processing, such as tomatoes, peaches, plums and grapes, can be utilized to extract valuable amounts of usable oil. Biotechnology, genetic engineering, enzyme technologies and new processes are all being utilized in lipids research to develop new and modified types of oil for different applications; such developments include the high oleic acid, sunflower and rapeseed oils. The development of cocoa butter substitute is another example.

This highly practical book reviews the methods of improving oil characteristics from existing sources, and the technology and economics of developing under-utilized sources. It is written for lipid chemists, chemical engineers, food technologists, cosmetologists and nutritionists. Graduate and undergraduate students will find value in the data.

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1 Present and future outlook of the world fats and oil supplies

V.K.S. SHUKLA

1.1 Introduction

Fats and oils are the most essential nutrients of both human and animal diets. They provide the most concentrated energy (9 kcal/g) of any foodstuff, supply essential fatty acids (which are precursors for the important hormones prostanoids), serve as carrier for fat soluble vitamins, make foods more palatable and contribute towards the feeling of satiety after eating.

The oil crops have been cultivated since antiquity. Rapeseed was described in the Indian Sanskrit writings of 2000 BC and sesame seed was already known in ancient times. For the past half century, the cultivation of oil-bearing plants has increased considerably. There are several species of plants in the world whose oil can be utilized for human consumption. Although Lennarts (1983) described forty different oilseeds, there are only ten edible oil crops of commercial value in the world market. Seven of these are seed crops (cottonseed, groundnuts, rapeseed, safflower seed, sesame seed, soybeans and sunflower seed), and three are tree crops (coconut, olives and oil palm/kernels). Cultivation of several of these crops (coconut with copra, and oil palm/palm kernels) is limited almost exclusively to developing countries, where the most favourable climatic and soil conditions are available. However, some are annual crops and some are perennial (tree) crops, and these have very different possibilities of responding to changes in the world market.

The palm fruit has no associated oilmeals and unlike other oilseeds it cannot be transported far for economical and quality reasons. It has to be processed fresh locally, immediately after harvest and then transported all over the world. However, other oil crops are capable of being converted into varying proportions of vegetable oil and meal and because of the relatively high protein content and relatively low cost of the flour, extensive efforts are being made to utilize these by-products of seed crushing as a dietary protein source for human consumption.

Although the main input in the production of vegetable oils and fats comes from agriculture, there are close links with sectors such as chemical and capital goods, which play highly important roles as depicted in Figure

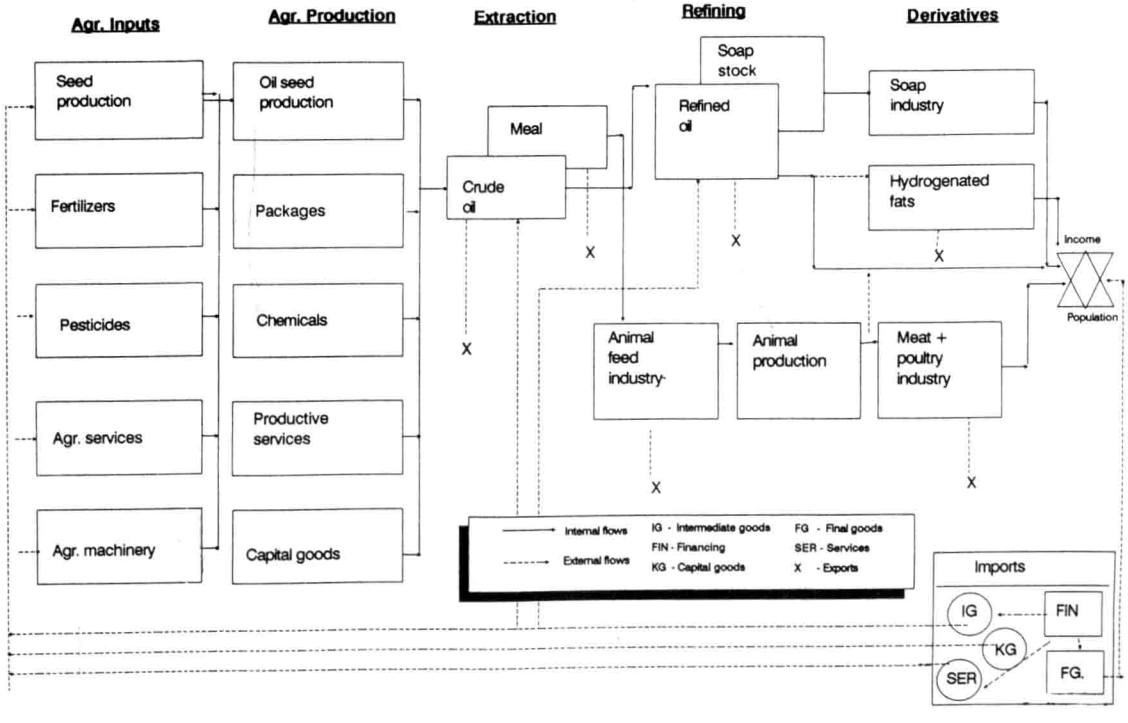

Figure 1.1 Vegetable oils and fats agro-industrial system: basic scheme.

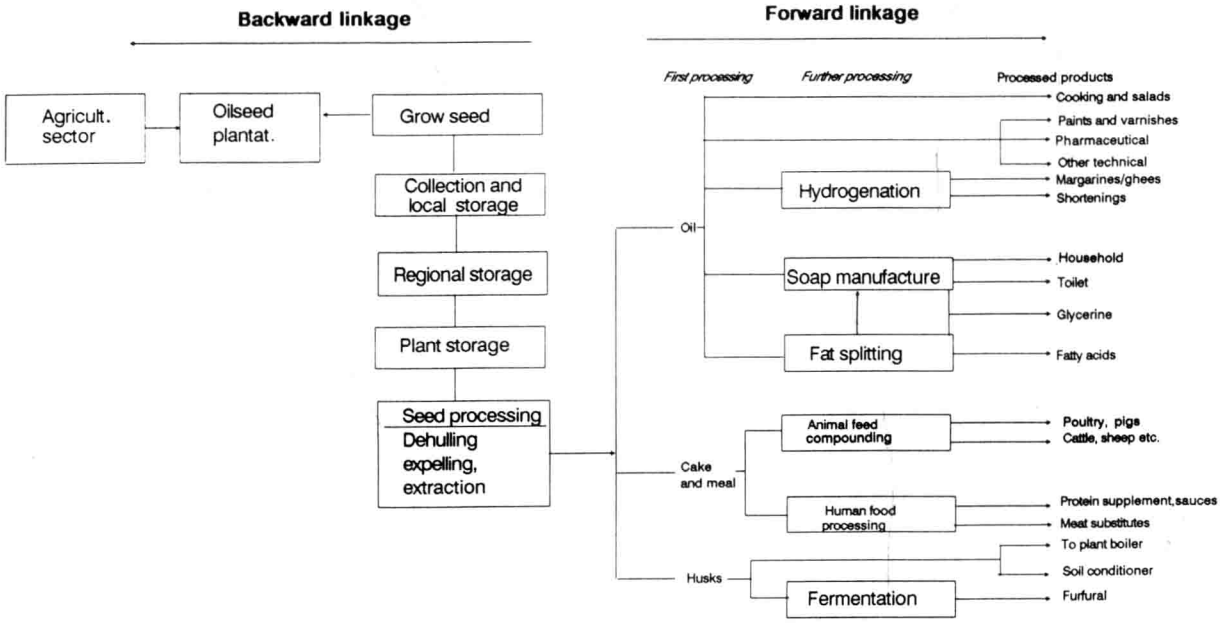

Figure 1.2 Intersectoral production linkages in the oilseed industry.

1.1. The industrially processed materials originating from vegetable oils and fats form the basis for the establishment of a varied chain of economically linked industries as shown in Figure 1.2. The cakes and meals are the basic raw materials for modern livestock feeding techniques linked with the industry of animal husbandry as shown in Figures 1.1 and 1.2, respectively.

Vegetable oils derived from the processing of oilseeds account for about 70% of the world's edible oils and fat production, the remainder being animal fats (30%), which include fish oils (2%). Out of the total world production of major oils and fats, about 80% is consumed as human food, a further 6% is used for animal feed, leaving 14% for the oleochemical industry (Richter and Knaut, 1984).

1.2 Composition of oils and fats

The most common fatty acids of plant and animal origin contain an even number of carbon atoms in straight chains with a terminal carboxyl group and may be fully saturated or contain (one to six) double bonds, which generally but not always have a *cis* configuration. Due to stereochemical effect, a double bond has the possibility of existing in two alternative isomeric forms, one in which the hydrogens attached to the carbons lie on the same side of the molecular chain (the *cis* form) and the other in which they lie on opposite sides (the *trans* form). Several vegetable oils contain trace amounts of natural *trans* fatty acids.

The fatty acids of animal origin are comparatively simple in structure and can be subdivided into well defined families. On the other hand, plant fatty acids may be more complex and contain a variety of other functional groups such as acetylenic bonds, epoxyl, hydroxyl, keto groups and cyclopropane rings.

Fatty acids do not exist normally in the free state. Fats and oils are predominantly triesters of fatty acids and glycerol, commonly called 'triglycerides'. These fatty acids may be saturated, mono-unsaturated or polyunsaturated. In addition to triglycerides, oils and fats also contain monoglycerides, diglycerides, phospholipids, galactolipids, free fatty acids emerging due to the action of lipases, and small amounts of substances such as sterols, terpenes, tocopherols and other fat soluble vitamins.

The fatty acid composition of major oil sources is shown in Table 1.1. The oils and fats have been divided according to the predominance of particular fatty acids such as saturated, mono-unsaturated and polyunsaturated. It is worth mentioning here that the fatty acid composition of particular oils and fats is variable according to the strain and climate; e.g. the linoleic acid content of corn oil varies between 35 and 60% and of peanut oil from 20 to 40%.