

FOOD INDUSTRY
BRIEFING SERIES

nutrition

Properties

**Oils and Fats
in the Food
Industry**

Frank D. Gunstone

Structure

 WILEY-BLACKWELL

Contents

<i>Series Editor's Foreword</i>	<i>viii</i>
<i>Preface</i>	<i>x</i>
<i>Abbreviations and Acronyms</i>	<i>xii</i>

Chapter 1 The Chemical Nature of Lipids 1

Chapter 1 describes those fatty acids that are important in foods and the glycerol esters in which these acids occur in the oils and fats used in the food industry. This is followed by a description of minor components also present including ester waxes, phospholipids, sterols, tocopherols, and hydrocarbons. Many of these minor components are valuable in their own right.

1.1 Fatty acids	1
1.2 Triacylglycerols	3
1.3 Ester waxes	5
1.4 Phospholipids	5
1.5 Sterols and sterol esters	7
1.6 Tocopherols	8
1.7 Hydrocarbons	10

Chapter 2 The Major Sources of Oils and Fats 11

Chapter 2 is devoted to the major commercial sources of oils and fats. These are mainly of plant origin but there is still a significant use of animal fats. Selected sources are discussed in terms of production levels and composition.

2.1 Introduction	11
2.2 Animal fats (butter, lard, tallow, chicken fat, and fish oils)	14
2.3 Cocoa butter and cocoa butter alternatives	16
2.4 Lauric oils (coconut, palm kernel)	17

2.5	Olive oil	18
2.6	Palm oil	19
2.7	Rapeseed (canola) oil	20
2.8	Soybean oil	21
2.9	Sunflower seed oil	22
2.10	Other vegetable oils	23
2.11	Single cell oils	24

Chapter 3 Extraction, Refining, and Modification Processes 26

Commodity oils have to be extracted from their agricultural source and are then usually refined to produce a bland product. However, the natural oils are not always optimum for their food-use purpose – they may fall short in terms of their physical, chemical, or nutritional properties – and procedures have been devised by which the oils come closer to what is desired. These procedures will be described. It is important that those in the food industry know what can be achieved and at what financial, environmental, or other cost.

3.1	Extraction	26
3.2	Refining	27
3.3	Modification processes	29
3.4	Blending	30
3.5	Fractionation including winterisation and dewaxing	31
3.6	Hydrogenation	31
3.7	Interesterification using a chemical catalyst	32
3.8	Interesterification using an enzymatic catalyst	33
3.9	Domestication of wild crops	34
3.10	Oilseeds modified by conventional seed breeding or by genetic engineering	34
3.11	Animal fats modified through nutritional changes	35

Chapter 4 Analytical Parameters 37

Commodity oils and fats are generally purchased with a specification. This chapter describes the terms which might appear on a specification and the analytical procedures by which these are measured.

4.1	Introduction	37
4.2	Oil content	38

4.3	Unsaturation – iodine value	39
4.4	Saponification – free acids, sap value	40
4.5	Melting behaviour, solid fat content, low-temperature properties	41
4.6	Oxidation – peroxide value, anisidine value, stability, shelf life, stability trials, taste panels	42
4.7	Gas chromatography	44
4.8	Near-infrared and Fourier transform infrared spectroscopy	47
4.9	^1H NMR spectroscopy	48
4.10	^{13}C NMR and ^{31}P NMR spectroscopy	51
4.11	Mass spectrometry	54

Chapter 5 Physical Properties 59

Important physical properties include crystallisation and melting, spectroscopic properties (covered in Chapter 4), and some others used in trading oils and fats.

5.1	Polymorphism, crystal structure, and melting point	59
5.2	Alkanoic and alkenoic acids	60
5.3	Glycerol esters	62
5.4	Ultraviolet spectroscopy	65
5.5	IR and Raman spectroscopy	66
5.6	Nuclear magnetic resonance spectroscopy	66
5.7	Mass spectrometry	66
5.8	Density	66
5.9	Viscosity	67
5.10	Refractive index	68
5.11	Solubility of gases in oils	68
5.12	Other physical properties	68

Chapter 6 Chemical Properties 71

Fatty acids and their esters have a carboxyl group and frequently contain one or more unsaturated centres (double bonds). Each of these functional groups has characteristic properties and those of greatest importance in the food industry are reviewed.

6.1	Hydrogenation	71
6.2	Atmospheric oxidation	75
6.3	Thermal changes	83
6.4	Reactions of the carboxyl/ester function	83

Chapter 7 Nutritional Properties 89

It is obvious that the nutritional properties of fats and oils and their various components will be of interest to the food industry. There is increasing awareness of the link between diet and health/disease. Links between chemical structure and physiological properties are discussed first followed by recommended dietary intake and the role of lipids in some of the more important disease conditions.

7.1	Introduction	89
7.2	EFA and fatty acid metabolism	92
7.3	<i>De novo</i> synthesis of saturated acids	93
7.4	Desaturation and elongation in plant systems	94
7.5	Desaturation and elongation in animal systems	95
7.6	Antioxidants	96
7.7	Cholesterol and phytosterols	97
7.8	Conjugated linoleic acid	98
7.9	Diacylglycerols	99
7.10	Recommended intake of fats and of fatty acids	100
7.11	Role of fats in health and disease	104
7.12	Obesity	105
7.13	Coronary heart disease	107
7.14	Diabetes	110
7.15	Inflammatory diseases	111
7.16	Psychiatric disorders	111
7.17	Cancer	112

Chapter 8 Major Edible Uses of Oils and Fats 113

The final chapter is devoted to a description of the most common food uses of oils and fats.

8.1	Introduction	113
8.2	Spreads – butter and ghee	113
8.3	Spreads – margarine, vanaspati, and flavoured spreads	115
8.4	Baking fats and shortenings	121
8.5	Frying oils and fats	123
8.6	Salad oils, mayonnaise and salad cream, French dressing	126
8.7	Chocolate and confectionery fats	127
8.8	Ice cream	131
8.9	Incorporation of vegetable fats into dairy products	131

8.10	Edible coatings	132
8.11	Emulsifying agents	133
8.12	Functional foods	134
8.13	Appetite suppressants	135
	References and Further Reading	137
	Useful Websites	140
	<i>Index</i>	141