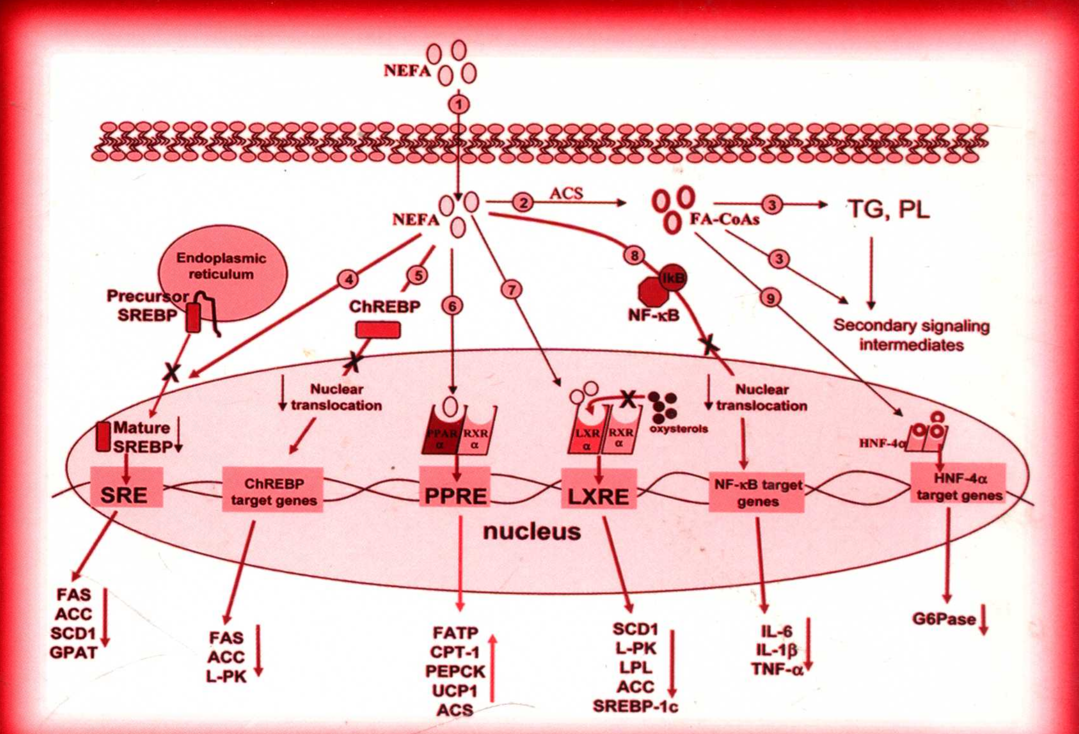
FATTY ACIDS IN FOODS *and their* HEALTH IMPLICATIONS

THIRD EDITION



edited by

CHING KUANG CHOW

CRC Press
Taylor & Francis Group

FATTY ACIDS IN FOODS *and their* HEALTH IMPLICATIONS

THIRD EDITION

edited by
CHING KUANG CHOW

CRC Press
Taylor & Francis Group
Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

Printed in the United States of America on acid-free paper
10 9 8 7 6 5 4 3 2 1

International Standard Book Number-10: 0-8493-7261-5 (Hardcover)
International Standard Book Number-13: 978-0-8493-7261-2 (Hardcover)

Library of Congress Cataloging-in-Publication Data

Fatty acids in foods and their health implications / editor, Ching K. Chow. -- 3rd ed.
p. ; cm. -- (Food science and technology ; 170)
"A CRC title."
Includes bibliographical references and index.
ISBN 978-0-8493-7261-2 (hardcover : alk. paper)
1. Fatty acids in human nutrition. 2. Food--Fat content. 3. Fatty acids--Health aspects. I. Chow, Ching Kuang, 1940- II. Series: Food science and technology (Taylor & Francis) ; 170.
[DNLM: 1. Fatty Acids. 2. Dietary Fats. 3. Nutrition Physiology. W1 FO509P v.170 2007 / QU 90 F254 2007]

QP752.F35F38 2007
612.3'97--dc22 2007007718

Visit the Taylor & Francis Web site at
http://www.taylorandfrancis.com

and the CRC Press Web site at
http://www.crcpress.com

FATTY ACIDS IN FOODS *and their* HEALTH IMPLICATIONS

THIRD EDITION

FOOD SCIENCE AND TECHNOLOGY

Preface

The first edition of this book volume was published in 1992, and the second edition in 1999 by Marcel Dekker, Inc., New York. Since then, volumes of new information on the fatty acids in various foods and food products, as well as their biological health effects have become available. In addition to quantity, the type of fatty acids consumed plays an important role in the etiology of a variety of degenerative diseases, including cardiovascular disease, cancer, immunity and inflammatory disease, renal disease, diabetes, neuromuscular disorders, liver disease, visual dysfunction, psychiatric disorders, and aging. Understanding the mechanisms by which fatty acids exert their biological effects is important in unraveling the pathogenesis of these disorders, and may help providing effective preventive measures.

Both animal- and plant-derived food products contain fat. Food fat provides taste, consistency, and helps us feel full. Fat is a major source of energy for the body, and aids in the absorption of lipid soluble substances including vitamins A, D, E, and K. Dietary fat is essential for normal growth, development, and maintenance, and serves a number of important functions. Increasing evidence indicates that fatty acids and their derived substances may mediate critical cellular events, including activation and expression of genes, and regulation of cellular signaling.

New reports or findings dealing with the health effects of various fatty acids have always commanded a strong public interest. In recent years, omega-3 and *trans* fatty acids have received more attention than others. On September 8, 2004, the Food and Drug Administration announced the availability of a qualified health claim for reduced risk of coronary heart disease on conventional foods that contain omega-3 fatty acids, eicosapentaenoic acid, and docosahexaenoic acid. While these fatty acids are not essential to the diet, scientific evidence indicates that these fatty acids may be beneficial in reducing coronary heart disease. On the other hand, recent scientific reports, expert panels, and studies concluded that consumption of *trans* fatty acids contributes to increased low-density lipoprotein cholesterol levels, which increase the risk of coronary heart disease. The Food and Drug Administration's final rule on *trans* fatty acids (or *trans* fat) requires manufacturers to list the amount of *trans* fat per serving on a separate line under saturated fat on the Nutrition Facts panel. As of January 1, 2006, food manufacturers must list the content of *trans* fat on the nutrition label. The health effects of α-linolenic acids and conjugated linoleic acid have also received considerable recent attention.

In recent decades, the prevalence of obesity or overweight has increased steadily in the United States and elsewhere. Currently over 40% of the adult population in the United States are considered as overweight or obese. Obesity is an important risk factor contributing to the development of the three leading causes of death—cardiovascular disease, cancer, and diabetes—and other disorders in the United States. As fat has much higher energy density than that of protein and carbohydrate, dietary fat is often blamed as the source of excess energy, although it is difficult to differentiate the effects of dietary fat and other energy nutrients independent of total energy intake. Evaluating trends in energy nutrient intake is useful in understanding the role of individual energy nutrients in the development of obesity and obesity-related illness over time. Also, investigation of the role of fatty acids in satiating effect and energy homeostasis is important in understanding food intake and energy balance issues.

Partly owing to the high-energy density, concerns over health problems associated with obesity and overweight have led to the development of several fat substitutes. The rapid advance in molecular biology and biotechnology has allowed for selective alteration of fatty acid composition in oil crops. It is now possible to commercially produce oil crops that contain a desirable proportion of specific fatty acids. Owing to distinct biological and health effects of various fatty acids, manipulation of the lipid composition in oil crops is likely to impact our well-being and economy enormously.

In addition to updating original chapters on the basis of available recent information, the following new chapters are added to cover the subject areas that were not covered or not adequately covered in the second edition: Fatty Acids in Fermented Food Products (Chapter 13), Effect of Heating and Frying on Oil and Food Fatty Acids (Chapter 20), Consumption of Fatty Acids (Chapter 21), Significance of Dietary γ-Linolenate in Biological Systems: Alternation of Inflammation and Proliferative Process (Chapter 32), Biological Effects of α-Linolenic Acid (Chapter 33), Biological Effects of Conjugated Linoleic Acid (Chapter 34), The Role of Omega-3 Polyunsaturated Fatty Acids in Food Intake and Energy Homeostasis (Chapter 35), and Fatty Acid and Cognition, Behavior and Brain Development, and Mood Disease (Chapter 39). Also, the following chapters were completely rewritten: Fatty Acids in Meat and Meat Products (Chapter 5), Fatty Acids in Milk Fat (Chapter 6), The Effects of Dietary Fatty Acids in Fatty Acid Metabolism (Chapter 23), Dietary Fatty Acids and Eicosanoids (Chapter 28), Fatty Acids and Aging (Chapter 40), and Essential Fatty Acids and Visual Dysfunction (Chapter 43). At the same time, several chapters that appeared in the second edition were not included in the third edition.

This updated and expanded book volume presents the current status of fatty acids in common foods and food products. It also aims to provide readers with state-of-the-art information on the widely diversified health implications of fatty acids. However, as the precise role of fatty acids in the etiology of various degenerative disorders is yet to be delineated, it is not the intention of this book volume to present a unified view on the health implications of fatty acids or to provide guidelines for fatty acid consumption.

I would like to express my sincere appreciation to all the authors of this book volume for their cooperation and excellent contributions. Without their participation and efforts this project would not be a reality. Also, I would like to thank Susan Lee and Amber Donley of Taylor & Francis for their assistance and support during the course of the project. Finally I wish to thank my wife Shukwei for her understanding and patience over the past many years.

Ching Kuang Chow

Contributors

Robert G. Ackman
Dalhousie University
Halifax, Nova Scotia, Canada

Casimir C. Akoh
University of Georgia
Athens, Georgia

Sara Bastida
Instituto del Frío (CSIC)
Madrid, Spain

Robert Becker
U.S. Department of Agriculture
Albany, California

Denovan P. Begg
School of Psychological Science
La Trobe University
Victoria, Australia

Carolyn D. Berdanier
University of Georgia
Athens, Georgia

Sam J. Bhathena
Phytonutrients Laboratory
Beltsville Human Nutrition Research Center
Agricultural Research Service
U.S. Department of Agriculture
Beltsville, Maryland
and
Department of Medicine
George Washington University
Washington, D.C.

Gilbert A. Boissonneault
Department of Clinical Sciences
Division of Clinical Nutrition
University of Kentucky
Lexington, Kentucky

Maria G. Boosalis
Division of Clinical Nutrition
University of Kentucky
Lexington, Kentucky

Jürgen T. Borlak
Solday Pharma
Hannover, Germany

Jean-Marie Edouard Bourre
INSERM
CNRS
Paris, France

Geza Bruckner
Department of Clinical Sciences and Clinical Nutrition
University of Kentucky
Lexington, Kentucky

Carolina B. Cabral
Massachusetts General Hospital
and
Harvard Medical School
Boston, Massachusetts

Austin H. Cantor
University of Kentucky
Lexington, Kentucky

Sue Joan Chang
National Cheng Kung University
Tainan, Taiwan

Robert S. Chapkin
Department of Nutrition and Food Science
Center for Environmental and Rural Health
Texas A&M University
College Station, Texas

Jennifer M.K. Cheong
Massachusetts General Hospital
and
Harvard Medical School
Boston, Massachusetts

Ching Kuang Chow
University of Kentucky
Lexington, Kentucky

Victoria P. Collins
Warren Wilson College
Asheville, North Carolina

Sarah M. Conklin
Department of Psychiatry
School of Medicine
University of Pittsburgh
Pittsburgh, Pennsylvania

Margaret C. Craig-Schmidt
Department of Nutrition and Food Science
Auburn University
Auburn, Alabama

Eric A. Decker
University of Massachusetts
Amherst, Massachusetts

John M. deMan
University of Guelph
Guelph, Ontario, Canada

Luc Djoussé
Harvard Medical School and the Department of Medicine
Brigham and Women's Hospital
Boston, Massachusetts

Carmen Dobarganes
Instituto de la Grasa y sus Derivados
Sevilla, Spain

Elizabeth A. Droke
Department of Nutrition, Food Service & Hospitality
South Dakota State University
Brookings, South Dakota

M. Enser
Division of Farm Animal Science
School of Clinical Veterinary Science
University of Bristol, United Kingdom

Howard Perry Glauert
Graduate Center for Nutritional Sciences
University of Kentucky
Lexington, Kentucky

Earl G. Hammond
Iowa State University
Ames, Iowa

Margit Hamosh
Georgetown University Medical Center
Washington, D.C.

Yung-Sheng Huang
Department of Biotechnology
Yuanpei University
Hsin-Chu, Taiwan

J. Edward Hunter
Cincinnati, Ohio

Daniel H. Hwang
U.S. Department of Agriculture
Agricultural Research Service
Western Human Nutrition Research Center
and
Department of Nutrition
University of California
Davis, California

Ronald Jandacek
Department of Pathology and Laboratory Medicine
University of Cincinnati
Cincinnati, Ohio

Robert G. Jensen
Department of Nutritional Sciences
University of Connecticut
Storrs, Connecticut

Markandeya Jois
Department of Agricultural Sciences
La Trobe University
Victoria, Australia

Yukio Kakuda
University of Guelph
Guelph, Ontario, Canada

Basil S. Kamel
Applied Technical Service
Brantford, Ontario, Canada

Joanne K. Kelleher
Massachusetts General Hospital and Harvard Medical School
Boston, Massachusetts

Darshan S. Kelley
Western Human Nutrition Research Center
U.S. Department of Agriculture
Agriculture research service and Department of Nutrition
University of California
Davis, Massachusetts

Kazunori Koba
Department of Nutrition
Siebold University of Nagasaki
Nagasaki, Japan

Joo Y. Lee
Department of Life Science
Gwangju Institute of Science and Technology
Gwangju, Korea

Kelly Lobb
Texas A&M University
College Station, Texas

Henry C. Lukaski
United States Department of Agriculture
Agricultural Research Service
Grand Forks, North Dakota

Gloria Márquez-Ruiz
Instituto del Frío (CSIC)
Madrid, Spain

Colleen M. McGuire
Department of Psychology
University of Maryland
Baltimore, Maryland

Matthew F. Muldoon
Center for Clinical Pharmacology
School of Medicine
University of Pittsburgh
Pittsburgh, Pennsylvania

Koji Nagao
Department of Applied Biochemistry and
Food Science
Saga University
Saga, Japan

Amin A. Nanji
Dalhousie School of Medicine
and
Queen Elizabeth II Health Sciences
Center
Halifax, Nova Scotia, Canada

Bassam A. Nassar
Dalhousie School of Medicine
and
Queen Elizabeth II Health Sciences
Center
Halifax, Nova Scotia,
Canada

James M. Ntambi
Departments of Biochemistry and Nutritional
Sciences
University of Wisconsin
Madison, Wisconsin

Donald L. Palmquist
Department of Animal Sciences
Ohio Agricultural Research and Development
Center
The Ohio State University
Wooster, Ohio

Andrew C. Peng
The Ohio State University
Columbus, Ohio

José L. Quiles
Institute of Nutrition and Food Technology and
Department of Physiology
University of Granada
Granada, Spain

M. Carmen Ramírez-Tortosa
Institute of Nutrition and Food Technology
and Department of Biochemistry and
Molecular Biology II
University of Granada
Granada, Spain

Charles J. Rebouche
Department of Pediatrics
University of Iowa College of Medicine
Iowa City, Iowa

Ravinder D. Reddy
Department of Psychiatry
School of Medicine
University of Pittsburgh
Pittsburgh, Pennsylvania

Christina Revelle
Department of Psychology
University of Maryland
Baltimore, Maryland

R. I. Richardson
Division of Farm Animal Science
School of Clinical Veterinary Science
University of Bristol,
United Kingdom

Harini Sampath
Department of Nutritional Sciences
University of Wisconsin
Madison, Wisconsin

Francisco J. Sánchez-Muniz
Departamento de Nutrición y Bromatología I
Facultad de Farmacia
Universidad Complutense de Madrid
Madrid, Spain

Andrew J. Sinclair
School of Exercise and Nutrition Sciences
Deakin University
Victoria, Australia

Lauren Stahl
School of Psychological Science
La Trobe University
Victoria, Australia

Béla Szepesi
United States Department of Agriculture
Beltsville, Maryland

Vickie Tatum
National Council of the Paper
Industry for Air and Steam
Improvement, Inc.
Gainesville, Florida

Carmen A. Teodorescu
Department of Nutrition and
Food Science
Auburn University
Auburn, Alabama

Madhuri Vemuri
Western Human Nutrition Research Center
U.S. Department of Agriculture
Agriculture Research Service, and
Department of Nutrition
University of California
Davis, California

Algis J. Vingrys
Department of Optometry and
Vision Sciences
The University of Melbourne
Parkville, Victoria,
Australia

Stuart K. Ware
University of Kentucky
Lexington, Kentucky

Zoe S. Warwick
Department of Psychology
University of Maryland
Baltimore, Maryland

Harrison S. Weisinger
St. Vincent's Hospital, Melbourne
Victoria, Australia

Richard S. Weisinger
School of Psychological Science
La Trobe University
Victoria, Australia

Vernon A. Welch
University of Reading, Whiteknights
Reading, United Kingdom

Anne E. Weymouth
Department of Optometry and Vision Sciences
The University of Melbourne, Parkville
Victoria, Australia

Pamela J. White
Iowa State University
Ames, Iowa

F. M. Whittington
Division of Farm Animal Science
School of Clinical Veterinary Science
University of Bristol, United Kingdom

J. D. Wood
Division of Farm Animal Science
School of Clinical Veterinary Science
University of Bristol, United Kingdom

Teruyoshi Yanagita
Department of Applied Biochemistry and
Food Science
Saga University
Saga, Japan

Jeffrey K. Yao
VA Pittsburgh Healthcare System
Pittsburgh, Pennsylvania
and
School of Pharmacy
University of Pittsburgh
Pittsburgh, Pennsylvania

Vincent A. Ziboh
Department of Dermatology
University of California
Davis, California

Contents

1 Fatty Acid Classification and Nomenclature

Kelly Lobb and Ching Kuang Chow

CONTENTS

I. INTRODUCTION

Fats or lipids consist of numerous chemical compounds, including monoglycerides, diglycerides, triglycerides, phosphatides, cerebrosides, sterols, terpenes, fatty alcohols, and fatty acids. Fatty acids constitute the main component of phospholipids, triglycerides, diglycerides, monoglycerides, and sterol esters. Fatty acids consist of elements, such as carbon, hydrogen, and oxygen, that are arranged as a linear carbon chain skeleton of variable length with a carboxyl group at one end. Fatty acids can be saturated (no double bond), monounsaturated (one double bond), or polyunsaturated (two or more double bonds), and are essential for energetic, metabolic, and structural activities.

Food scientists, nutritionists, biochemists, chemists, and biomedical scientists alike recognize the need for a coherent nomenclature for fatty acids. There are a number of nomenclature systems for fatty acids, and some researchers continue to name fatty acids traditionally on the basis of the names of the botanical or zoological species from which they are isolated. Such naming system provides no clue as to the structure of fatty acids. The International Union of Pure and Applied Chemistry (IUPAC) and the International Union of Biochemistry (IUB) attempted to deal with this problem by setting up two nomenclature committees, the IUB-IUPAC Joint Commission of Biochemical Nomenclature (JCBN) and the Nomenclature Committee of IUB (NC-IUB). IUPAC states definitive rules of nomenclature for organic chemistry (1960) and lipids (1978), Markely (1960) presents a historical review of chemical nomenclature, and Fletcher et al. (1974) discuss the origin and evolution of organic nomenclature. Other excellent reference sources for fatty acid classifications and nomenclatures include Fahy et al. (2005), Fasman (1989), Gunstone (1996, 1999), Gunstone et al. (1992), Gunstone and Herslof (1992), Hopkins (1972), and Robinson (1982).

II. NOMENCLATURE

According to the strictest rules of nomenclature, a chemical name must identify and describe its chemical structure unambiguously. This is done by using systematic nomenclature, and there is no possibility of mistaken identity when this system is used. The systematic method names fatty acids solely on the basis of the number of carbon atoms and the number and position of unsaturated bonds relative to the carboxyl group(s). Substituted groups and their positions are identified. Optical activity and geometric configuration at double bonds are also designated. Systematic nomenclature will be described generally for the saturated fatty acids and then for other types of fatty acids as necessary thereafter.

It is also important to note that there are modifications to this naming system that bring novel naming systems into existence. Trivial (common) nomenclature, which includes circumstantially assigned names, for example, source names, is widely used. The English system of trivial name arose from the practice of adding the suffix "-ic" to a root indicative of the natural source or some property of the acid; for example, acetic (ethanoic) acid from the Latin word *acetum*, meaning vinegar; stearic (octadecanoic) acid from the Greek word *stear*, meaning tallow; palmitic (hexadecanoic) acid from palm oil; and oleic (octadecenoic) acid from the Latin word *oleum*, meaning oil.

Semisystematic nomenclature is often found in verbal communication and as an abbreviation in written communication. This system tries to preserve some of the structural features of systematic nomenclature, yet does so using trivial names, illustrating features that seem important for a particular purpose at the time. For example, the systematic name 2-hydroxy-*cis*-9, *cis*-12, *cis*-15-octadecatrienoic acid might become abbreviated to 2-hydroxylinolenic acid.

Also widely used is the structural system in which fatty acids are identified solely by carbon number and number of unsaturated double bonds. Morris (1961) has proposed that chain length be designated as C10, C20, and so forth, and the unsaturated double bonds be serialized. That is, either methylene-interrupted or conjugated, only the number of the carbon where the series begins will be indicated. For example, linolenic acid, or *cis*-9, *cis*-12, *cis*-15-octadecatrienoic acid, becomes C18:3Δ9c.

The Greek letters omega (ω) and delta (Δ) are sometimes used with special significance in naming fatty acids. Omega is often used to indicate how far a double bond is from the terminal methyl carbon irrespective of the chain length. Delta, followed by a numeral or numerals, is used to designate the presence and position of one or more double or triple bonds in the hydrocarbon chain counting from the carboxyl carbon. Thus, ordinary oleic acid is also named Δ9-octadecenoic acid.

Another system of nomenclature in use for unsaturated fatty acids is the "ω" or "n" classification, and the "n" system is analogous to the "ω" naming system. This system is often used by biochemists to designate sites of enzyme reactivity or specificity. The terms "ω" and "n" refer to the position of the first double bond in the carbon backbone of the fatty acid, counting from the end opposite to the carboxy group or closest to the methyl end of the molecule. Thus, oleic acid, which has its double bond nine carbons from the methyl end, is an ω-9 (or n-9) fatty acid, and linoleic acid is an ω-6 (or n-6) fatty acid because its second double bond is six carbons from the methyl end of the molecule (or between carbons 12 and 13 from the carboxyl end). Eicosapentaenoic acid, found in many fish oils, and alpha-linolenic acid, found in certain vegetable oils, are both ω-3 (or n-3) fatty acids, which have the first double bond that exists as the third carbon–carbon bond from the terminal methyl end (ω) of the carbon chain. Also, both ω- and n-naming methods give a clear indication of the stereoisomeric species concerned; for example, *cis* C20:4n-6 and *cis* C20:4ω-6. The first number indicates the number of carbon units, the second number refers to the number of double bonds, and the n-6 or ωω-6 designation refers to the position of the last double bond. Both the "ω" and "n" nomenclature methods used to designate the position of the last terminal double bond are interchangeably used, however, the "n-3" designation is the proper IUPAC abbreviation. See Davidson and Contrill (1985) for a comparison of the "n" and "ω" naming systems.

The nomenclature of some common fatty acids using the four common naming systems is shown in Table 1.1. Of which, three systems employ the chain length and the number and position of any double bond. The first two columns show systems based on complete names and the last two columns show systems for denoting fatty acids with abbreviations.

Although the IUPAC system is unambiguous, some authors still select a nomenclature system according to their audience. Also, criteria for a suitable abbreviated terminology have been proposed but have yet to be universally adapted. Questions of which abbreviated terms are most appropriate

TABLE 1.1
Nomenclature of Some Common Fatty Acids

Names		Abbreviation	
Trivial	**IUPAC**	**Carboxyl-Reference**	**n- or ω-Reference**
Palmitic acid	Hexadecanoic acid	16:0	16:0
Stearic acid	Octadecanoic acid	18:0	18:0
Oleic acid	9-Octadecenoic acid	18:1Δ9	18:1n-9 or 18:1–9
Linoleic acid	9,12-Octadecadienoic acid	18:2Δ9,12	18:2n-6 or 18:2–6
Linolenic acid	9,12,15-Octadecatrienoic acid	18:3Δ9,12,15	18:3n-3 or 18:3–3

for representing the long and complicated chemical names will continue until an accepted system of nomenclature for individual fatty acids is agreed upon.

III. SATURATED FATTY ACIDS

The naturally occurring fatty acids can be grouped on the basis of the presence of double or triple bonds into two broad classes termed *saturated* and *unsaturated*. Most of the saturated fatty acids occurring in nature have unbranched structures with an even number of carbon atoms. They are referred to as normal alkanoic acids and may bear the prefix "*n*-," such as in *n*-hexanoic or *n*-octadecanoic. They have the general formula R–COOH, in which the R group is a straight-chain hydrocarbon of the form $CH_3(CH_2)_x$ or C_nH_{2n+1}. These acids range from short-chain-length volatile liquids to waxy solids having chain lengths of ten or more carbon atoms. Fatty acids from 2 to 30 carbons (or longer) do occur, but the most common and important acids contain between 12 and 22 carbons and are found in many different plant and animal fats. Under the systematic rules of nomenclature, the aliphatic acids are regarded as derivatives of hydrocarbons of the same number of carbon atoms ($-CH_3$ is replaced by –COOH). The final "e" of the corresponding hydrocarbon (alkane) is replaced by the suffix "-oic"; for example, alkane becomes alkanoic. The unsaturated fatty acids are named in a similar manner, with alkene becoming alkenoic and alkyne becoming alkynoic. The presently accepted names for the hydrocarbons are given in Table 1.2. The tables in this and the following sections are representative only, not complete. Except for the first four members of the series (meth-, eth-, prop-, but-), which have trivial names, the prefix of the name cites the number of carbon atoms.

Saturated fatty acids are also functionally divided into short- and long-chain acids and are most widely known by their trivial names. Table 1.3 lists some of the most important saturated fatty acids. Also included is a system of abbreviated nomenclature that designates chain length and degree of unsaturation; for example, 18:0 designates an 18-carbon saturated fatty acid, whereas 18:2 indicates two double bonds. The location of unsaturations as well as conformation of double bonds can also be designated; 18:2Δ9c, 12c designates *cis* double bonds at the 9 and 12 carbons from the carboxyl group. Similar designations will be described for hydroxy, keto, and so on.

The short-chain saturated acids (4:0–10:0) are known to occur in milk fats and in a few seed fats. Bovine milk contains butanoic acid as well as smaller amounts of 6:0, 8:0, 10:0, and 12:0 acids. Milk from the sheep and goat also contain these, but decanoic is present in larger amounts. Lauric acid (12:0) and myristic acid (14:0) are major components of seed fats of the Lauraceae and Myristiceae families, which accounts for their trivial names. Palmitic acid is the most prominent saturated fatty acid occurring in fish oils, in the milk and storage fat of many mammals, and in vegetable fats. Stearic acid (18:0) is a minor component in most vegetable fats, and its trivial name derives from the fact that it is a major component in the tallow of ruminants.

The long-chain saturated acids (19:0 and greater) are major components in only a few uncommon seed oils. Although many types of fatty-acid-containing oils are present in natural sources, only