PROCESSING FRUITS: SCIENCE AND TECHNOLOGY

Major Processed Products

Edited by

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VOLUME 2

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TECHNOMIC
PUBLISHING CO., INC.
LANCASTER · BASEL

Processing Fruits: Science and Technology—Volume 2

a **TECHNOMIC** publication

Published in the Western Hemisphere by
Technomic Publishing Company, Inc.
851 New Holland Avenue, Box 3535
Lancaster, Pennsylvania 17604 U.S.A.

Distributed in the Rest of the World by
Technomic Publishing AG
Missionsstrasse 44
CH-4055 Basel, Switzerland

Printed in the United States of America
10 9 8 7 6 5 4 3 2 1

Main entry under title:
Processing Fruits: Science and Technology—Volume 2:
Major Processed Products

A Technomic Publishing Company book
Bibliography: p.
Includes index p. 545

Library of Congress Catalog Card No. 96-60128
ISBN No. 1-56676-383-5

MAJOR PROCESSED PRODUCTS

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Preface

FRUIT consumption has enjoyed unprecedented growth during the past decade. Consumers are eating more fruit as they learn about the many health benefits attributed to fruit constituents by current nutrition studies. The importance of dietary fiber, antioxidants, vitamins, minerals and the many phytochemicals present in fruits is discussed almost daily—although occasionally overstated—by the news media. At the same time the variety of fruits sold for extended periods throughout the year in the developed countries has increased. Many tropical fruits that used to be considered exotic and expensive are now commonly consumed as fresh produce, or used as favored ingredients in juice blends, snacks, baby food and many other processed foods.

The critical advances in fruit processing technologies that serve these market trends are less obvious. The emphasis in fruit preservation has shifted from traditional methods of canning, freezing and dehydration to the "fresh cut"—nearly fresh fruit preparations. Shelf life extension of produce via fruit irradiation is now practiced in many countries, as is the use of modified atmosphere packages for produce distributed to food service and to retail stores. Because consumers favor products that contain fruit, food manufacturers are using more fruits as value-added ingredients in forms ranging from fruit concentrates to more sophisticated fruit preparations.

These two volumes present information about the latest developments and about more traditional fruit processing methods. In Volume 1, starting with the postharvest handling of fruits, we discuss all food processing technologies that are applied to fruit preservation. Also included in this volume are other essential features of fruit processing operations, such as: the food additives used, microbiology, quality assurance, packaging, grades and standards of fruits, and waste management.

In Volume 2, we cover the important processed fruit and nut commodities and discuss the process technologies applied to them. Although we cannot cover all fruit commodities that are processed today, the reader will find representative examples for each major fruit category, including: pome fruits, drupe fruits, grapes and other berries, citrus and other tropical and subtropical fruits, oil fruits and nuts.

The global character of the fruit industry is confirmed by the participation of contributing authors from six countries; each of the authors has first-hand academic research, or industrial experience related to their topics. We have made a concerted effort to provide the reader with comprehensive and current information on a wide variety of fruits and processes. We are grateful to each of the authors for their contributions and assistance in this venture, as well as to our many colleagues in the industry for their advice and encouragement.

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CHAPTER 1

Apples and Apple Processing

WILLIAM H. ROOT[1]

THE apple has been grown by man since the dawn of history. It is mentioned in early legends, poems, and religious books. The "fruit" that the Bible says Adam and Eve ate in the Garden of Eden is believed by many to have been an apple. The ancient Greeks had a legend that a golden apple caused quarreling among the gods and brought about the destruction of Troy. The Greek writer Theophrastus mentions several cultivars grown in Greece in the fourth century B.C. Apple trees were grown and prized for their fruit by the people of ancient Rome.

The apple species, *Malus pumila*, from which the modern apple developed, had its origin in southwestern Asia in the area from the Caspian to the Black Sea. The stone age lake dwellers of central Europe used apples extensively. Remains found in their habitations show they stored apples fresh and also preserved them by cutting and drying in the sun. The apple was brought to America by early colonists from Europe.

Some cultivars originating in Europe were grown by the colonists, but the main method of planting apples in the new land was by seed. As the pioneers migrated westward, they carried apple seeds with them and established plantings where they settled. Almost everyone is familiar with John Chapman, "Johnny Appleseed," born June 1776 in Leominster, Massachusetts, and the story of how he carried apples west like many of the early settlers.

In these early times, most of the apple crop was home processed into cider. The common seedling trees were satisfactory for this cider production. Not many of the cultivars brought across the Atlantic by the early settlers adapted well to the North American climate. There was a need to de-

[1]Tree Top, Inc. (retired), Walnut Creek, CA, U.S.A.

velop American cultivars from the seedlings to improve the apple production and storage characteristics. Those selected cultivars were given local names (Upshall, 1970).

U.S. AND WORLD APPLE PRODUCTION

The apple is more widely grown than any other fruit. Apple trees of one cultivar or another grow all around the world but are mainly concentrated in the northern hemisphere. About 95% of all apples grown, with some exceptions due to isolated micro-climates, are found between the 35° N and 50° N latitudes and between the 30° S and 45° S latitudes. These bands of primary apple-growing areas around the globe are shown in Figure 1.1.

Current annual world production is about 40 million metric tons per year. Commercial apple production for the United States is about 5 million U.S. tons per year. World apple production trends are shown in Table 1.1. Apple production in the United States is primarily in the states of Washington, New York, Michigan, California, and Pennsylvania. These states produce over three-quarters of the total U.S. production. The other regions—New England, eastern, central, and other western states—produce the final one-quarter.

A distribution of the 1992–1993 apple production, by state, is shown in Table 1.2. Distribution of apple production in specified countries for 1992–1993 is presented in Table 1.3. Depending on the climate in any region of the world, apple production can vary by 15–20% from year to year.

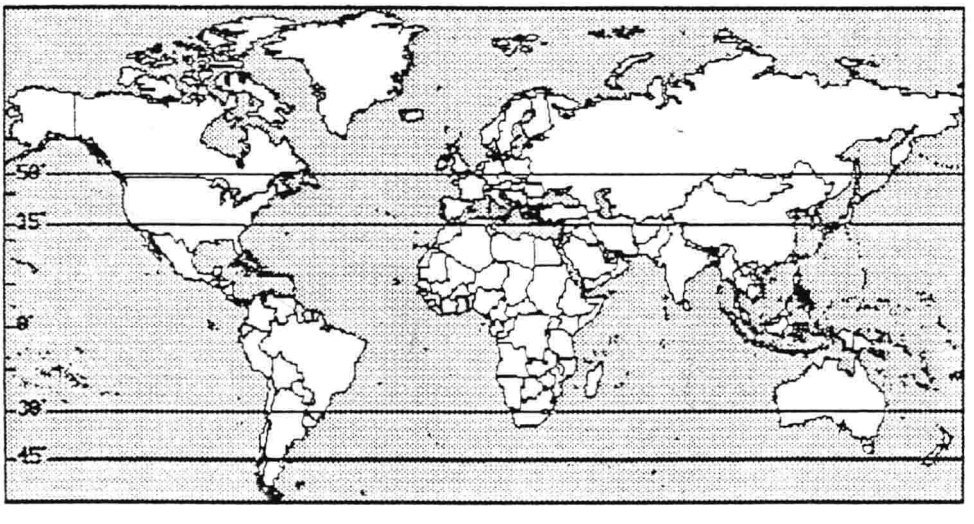

Figure 1.1 Primary apple growing latitudes of the world.

TABLE 1.1. World Apple Production Trends (1986 through 1993 in million metric tons).

	1986	1987	1988	1989	1990	1991	1992	1993
North America	4.31	5.92	4.81	5.31	5.45	5.46	5.82	5.83
Europe	13.03	11.20	12.00	11.49	11.46	10.87	16.11	14.12
Asia	10.52	11.29	11.57	10.72	11.95	11.89	14.36	14.38
So. Hemisphere	2.39	2.85	2.77	2.87	2.96	3.25	3.08	3.26
World Total	30.69	31.85	31.62	30.92	32.37	33.50	41.19	39.35

Source: USDA, FAO.

The U.S. and world production of apples continues to increase. In 1993, production in the United States was about 30% higher than the previous years. The trend in U.S. production is shown in Figure 1.2, which was due to development of newer high-density plantings and increased size of the young bearing trees, particularly in Washington and California. Ideal climatic conditions have resulted in record U.S. crops in recent years. Canada produced about 570,000 metric tons of apples in 1992–1993. Canadian apple production is centered mainly in the provinces of Ontario, British Columbia, and Quebec. Production in many developed countries is ex-

TABLE 1.2. United States Production in 42-lb Boxes of Apples (by states for crop year 1992–1993).

State	42-lb Units × 1,000	State	42-lb Units × 1,000
Arizona	2,143	New Hampshire	1,286
California	20,000	New Jersey	1,310
Colorado	2,143	New Mexico	357
Connecticut	1,000	New York	27,857
Delaware	476	North Carolina	5,714
Georgia	595	Ohio	2,857
Idaho	1,786	Oregon	4,167
Illinois	2,085	Pennsylvania	11,905
Indiana	1,667	Rhode Island	155
Iowa	333	South Carolina	1,429
Kansas	143	Tennessee	310
Kentucky	381	Utah	1,429
Maine	1,976	Vermont	1,190
Maryland	1,190	Virginia	8,810
Massachusetts	2,024	Washington	114,286
Michigan	25,714	West Virginia	5,357
Minnesota	690	Wisconsin	1,500
Missouri	881	Total United States	256,881

Source: *Marketing Northwest Apples.* 1992 Crop, USDA, AMS, Fruit and Vegetable Division.

TABLE 1.3. **Production of Apples in Specified Countries (for 1992/93 in 1,000 metric tons).**

Northern Hemisphere			
Austria	233	Mexico	545
Benelux	492	Netherlands	570
Canada	511	Norway	45
Denmark	83	Spain	1,027
France	2,398	Sweden	72
Germany	2,951	Switzerland	118
Greece	350	Taiwan	13
Hungary	666	Turkey	2,100
Italy	2,386	United Kingdom	337
Japan	1,039	United States	5,357
	Northern Hemisphere Total		30,183
Southern Hemisphere			
Argentina	1,050	New Zealand	497
Australia	321	South Africa	630
Chile	810		
	Southern Hemisphere Total		3,258

Source: United States Department of Agriculture, World Statistics from USDA FAS World Horticultural Trade and U.S. Export Opportunities, March 1994.

pected to level off or decline because of overproduction. World production is increasing because of previously unreported production of countries not shown in Table 1.2: for example, China, one of the world's largest apple-producing areas, estimated to be over 7 million metric tons; Commonwealth of Independent States (CIS), formerly the USSR, estimated at over 6 million metric tons; Poland, 1 million tons; Korea, 650,000 tons; and Romania, 550,000 tons. These large-volume, apple-producing countries may export more in the future (*FAO Production Yearbook,* 1991).

Production and utilization of apples in the United States of America has

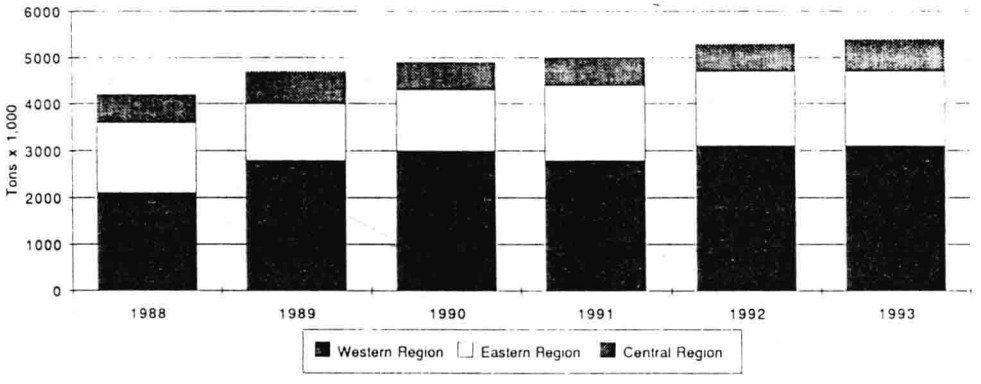

Figure 1.2 U.S. apple production trends—1988 to est. 1993.