CRC

POSTHARVEST BIOTECHNOLOGY of FRUITS

Volume II

D. K. Salunkhe
B. B. Desai

CRC PRESS

POSTHARVEST BIOTECHNOLOGY OF FRUITS

Volume II

Authors

D. K. Salunkhe, Ph.D.
Vice-Chancellor
Mahatma Phule Agricultural University, Rahuri
Maharashtra State, India

B. B. Desai, Ph.D.
Associate Professor, Postharvest Technology
Mahatma Phule Agricultural University, Rahuri
Maharashtra State, India

CRC Press, Inc.
Boca Raton, Florida

Library of Congress Cataloging in Publication Data

Salunkhe, D. K.
Postharvest biotechnology of fruits

Bibliography: p.
Includes index
1. Fruit—Marketing. 2. Tropical fruit—Marketing.
3. Fruit—Processing. 4. Tropical fruit—Processing.
I. Desai, B. B., 1941- . II. Title.
SB360.S34 1984 634'.046 83-7770
ISBN 0-8493-6121-4 (v. 1)
ISBN 0-8493-6122-4 (v. 2)

Direct all inquiries to CRC Press, Inc., 2000 Corporate Blvd., N.W., Boca Raton, Florida, 33431.

Second Printing, 1986

International Standard Book Number 0-8493-6121-4
International Standard Book Number 08493-6122-4

Library of Congress Card Number 83-7770
Printed in the United States

PREFACE

Increasing the availability of food has become an ever more pressing problem, with the world population expanding at a faster rate than that of food production. The growth in world food production is thus losing momentum relative to population growth. Projections of the World Food and Nutrition Study indicate that food production must be increased by about 3 to 4%/year by the end of 20th century to meet the needs of annual population increases. Obviously, world food supplies will need to increase at more rapid rates in the future than they have in the past if all the people are to be fed adequately. This is the greatest challenge ever presented to agricultural scientists and food technologists.

The present plateau of yields of the major food crops is a significant reversal. World hunger is widespread and growing. According to World Bank estimates, about three-fifths of the people in poor and less-developed countries do not meet their caloric and protein needs. The FAO figures state that about half a billion people in developing countries suffer from serious malnutrition and undernutrition. Thus, there is a great need to increase food supplies, especially protective foods such as fruits and vegetables which are valuable sources of essential nutrients, minerals, vitamins, and fiber.

A major and often neglected step toward offering a greater volume of nutritious food is to prevent its loss between the time of harvesting and consumption. It is estimated that due to defects and inadequacies in postharvest handling, transportation, storage, and marketing of food products, losses of more than 25 to 30% occur, especially in less-developed tropical and subtropical countries where there is an acute shortage of nutritious food. Such losses in respect to perishable products like fresh fruits and vegetables are of much higher magnitude. According to a report published by the National Research Council of the National Academy of Sciences, Washington, D.C., 1978, postharvest losses of fruits, vegetables, and roots may be as high as 80 to 100%, in some instances. Owing to their high moisture content, fruits and vegetables give a shrivelled look and stale appearance, with a loss of even 10 to 15% in their fresh weight, lowering their market value and consumer acceptance considerably.

Supplies of fresh fruits and vegetables can be increased to the extent of their existing postharvest losses, with the application of adequate technology to prevent their deterioration after harvest. Recent developments in agriculture have contributed significantly to improving our total world food production and quality of food. New biotechnologies are being evolved to protect valuable food materials, leading to a major revolution in "engineering a new agriculture" in the developing countries.

Developments in technologies of pre-treatment of raw fruit and vegetable products include the following: improved methods of harvesting and handling; various dehydration techniques (sun drying, freeze and osmotic dehydration, accelerated freeze drying, liquid nitrogen and cryogenic freeze concentration, dehydrofreezing and dehydrocanning, and freeze leaching for quality improvement), refrigeration, pre-cooling and cold storages; controlled, modified and subatmospheric (hypobaric) storages; radurization (pasteurization with radiation); use of preharvest and postharvest application of different chemicals (fungicides, ethylene absorbents, antitranspirants, wax-emulsions, antioxidants, in-package desiccants, senescence-retardants, antibiotics, and growth regulators); physical methods of food protection like use of new packaging materials and techniques; and processing of fruit and vegetable products into more stable products such as jams, jellies, preserves, juice, powders, purees, frozen disks or chunks, mixed beverages, baby foods, candies, tutti-fruitties, etc.

The main purpose of these volumes is to review and bring into focus the most significant scientific developments which have taken place in the area of postharvest biotechnology of loss reduction of fruits. The opportunity and potential impact of these newly developing biotechnologies to increase food supplies in such less-developed countries as India are enormous.

D. K. Salunkhe
B. B. Desai

THE AUTHORS

Professor D. K. Salunkhe, Vice-Chancellor, Mahatma Phule Agricultural University, Rahuri (Maharashtra) was a former Professor of Nutrition and Food Science at Utah State University, Logan, Utah (U.S.). Under his guidance, 80 postgraduate students received their M.S. or Ph.D. degrees. He has authored over 300 scientific papers, book-chapters, and reports. Some of his articles received recognition and awards as outstanding articles in biological journals.

He was an Alexander Humboldt Senior Fellow and a Guest Professor at the Technical University in Karlsruhe, West Germany. He was a Guest Lecturer at the Technological Institute, Moscow, USSR, and an exchange scientist to Czechoslovakia, Rumania, and Bulgaria on behalf of the National Academy of Sciences, National Research Council, as well as advisor to U.S. Army food research laboratories and many food storage, processing, and consumer organizations.

Professor Salunkhe was Sigma Xi President, Utah State University Chapter; Fellow of Utah Academy of Sciences, Arts and Letters; Fellow of the Institute of Food Technologists and Danforth Foundation Faculty Associate. He delivered the Utah State University's 50th Faculty Honor Lecture, "Food, Nutrition, and Health: Problems and Prospect", on the basis of his creative activities in research and graduate teaching.

Professor Salunkhe is presently a member of the editorial boards of the *Journal of Food Biochemistry, International Journal Qualitas Plantarum/Plant Food for Human Nutrition, Journal of Food Science, International Journal of Utilization Research,* and *Journal of Food Quality.*

He authored two textbooks: *Storage, Processing and Nutritional Quality of Fruits and Vegetables* (CRC Press, 1974) and *Post-Harvest Biology and Handling of Fruits and Vegetables,* with Professor Haard, (AVI Publishing Co., 1975).

In addition, Professor Salunkhe has recently coauthored the following books: *Guidelines for the Preparation of Theses and Dissertations,* D. K. Salunkhe, J. K. Chavan, and Urmilla D. Salunkhe, MPAU, Rahuri, 1982; *Preparation and Presentation of Scientific Publications,* D. K. Salunkhe and D. R. Bapat, MPAU, Rahuri, 1982; and *Preparation of Research Proposals for Financial Support,* D. K. Salunkhe and S. S. Kadam, MPAU, Rahuri, 1983.

Professor Salunkhe married Urmilla P. Shinde in 1955. They have two children: Kirti and Vishwas.

Dr. B. B. Desai is Associate Professor of Postharvest Technology, Mahatma Phule Agricultural University, Rahuri, India. He was born in India in 1941. He graduated with a B.Sc. (Agriculture) degree with honors from Poona University in 1963; during the same year he was appointed as a demonstrator in Agricultural Chemistry and promoted to lecturer's position in 1965. He has been an Associate Professor since 1973. He received his M.Sc. (Agriculture) and Ph.D. degrees from Mahatma Phule Agricultural University, Rahuri, and University of Agricultural Sciences, Bangalore, respectively. During his wide teaching and research experience, Dr. Desai has taught courses in organic chemistry, biochemistry, analytical chemistry, agricultural chemicals, food chemistry, biochemical techniques, and postharvest technology of fruits and vegetables to both undergraduate and graduate students.

Dr. Desai has authored over 35 scientific papers and reports in national and international journals, coauthored two books on agriculture in Marathi, and has contributed a half-dozen chapters in different books being published currently. He has guided 15 students for their master's degrees and is a major advisor for two Ph.D. students.

Dr. Desai married Vilasini A. Patil in 1966. They have three children: Varsha, Vikas, and Savita.

Volume Outlines for *Postharvest Biotechnology of Fruits*

Volume I

Introduction
Methods of Food Loss Assessment and Estimation
Fruits—General Considerations
Banana and Plantain
Citrus
Mango
Small Fruits — Grape
Small Fruits — Berries
Deciduous Fruits — Apple and Pear
Stone Fruits

Volume II

Introduction
Pineapple
Papaya
Avocado
Guava
Fig
Passion Fruit
Sapòta
Pomegranate
Coconut
Lychee
Tamarind
Acerola
Nut Crops
Persimmon
Date
Loquat, Mangosteen, and Durian
Jackfruit and Breadfruit, Amla, Phalsa, Jamun, Bael and Wood Apple, and Mulberry
Custard Apple and Jujube

Volume Outlines for *Postharvest Biotechnology of Vegetables*

Volume I

Introduction
Assessment of Postharvest Losses of Vegetables and Loss Reduction Biotechnology
Vegetables: General Considerations
Tomato
Potato and Sweet Potato
Peas and Beans
Cole Crops (Crucifers)
Leafy Vegetables

Volume II

Introduction
Celery, Lettuce, and Endive
Onion and Garlic
Eggplant
Pepper (Capsicum sp.)
Okra
Cucumber, Melon, Pumpkin, and Squash
Root Vegetables: Beet, Carrot, Radish, Turnip, Rutabaga, and Horseradish
Sweet Corn
Asparagus and Artichoke
Yam, Taro, and Cassava
Mushroom
Prospects and Perspectives

TABLE OF CONTENTS

Volume II