



**POSTHARVEST PHYSIOLOGY
AND STORAGE OF TROPICAL
AND SUBTROPICAL FRUITS**

Edited by **Sisir Mitra**



CAB INTERNATIONAL

Postharvest Physiology and Storage of Tropical and Subtropical Fruits

Edited by

S.K. Mitra

Faculty of Horticulture

Bidhan Chandra Krishi Viswavidyalaya

Mohanpur, 741252

Nadia, West Bengal, India

CAB INTERNATIONAL

CAB INTERNATIONAL
Wallingford
Oxon OX10 8DE
UK

Tel: +44 (0)1491 832111
Fax: +44 (0)1491 833508
E-mail: cabi@cabi.org

CAB INTERNATIONAL
198 Madison Avenue
New York, NY 10016-4314
USA

Tel: +1 212 726 6490
Fax: +1 212 686 7993
E-mail: cabi-nao@cabi.org

© CAB International 1997. All rights reserved. No part of this publication may be reproduced in any form or by any means, electronically, mechanically, by photocopying, recording or otherwise, without the prior permission of the copyright owners.

A catalogue record for this book is available from the British Library, London, UK

Library of Congress Cataloging-in-Publication Data

Postharvest physiology and storage of tropical and subtropical fruits /edited by S.K. Mitra.

p. cm.

Includes bibliographical references and index.

ISBN 0-85199-210-2 (alk. paper)

1. Tropical fruit – Postharvest physiology. 2. Tropical fruit Storage. 3. Tropical fruit – Postharvest diseases and injuries.

I. Mitra, S.K.

SB359.P585 1997

634'.6–dc21

97-13568

CIP

ISBN 0 85199 210 2

Typeset in 10/12pt Palatino by Columns Design Ltd., Reading
Printed and bound in the UK by Biddles Ltd, Guildford and
King's Lynn

Contributors

- Abbas, M.F.** *College of Agriculture, Basrah University, Basrah, Iraq*
- Ali, Z.M.** *Department of Biochemistry, Faculty of Life Science, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia*
- Baldwin, E.A.** *United States Department of Agriculture, South Atlantic Area Citrus and Subtropical Products Laboratory, 600 Avenue S.N.W., PO Box 1909, Winter Haven, FL 33881, USA*
- Bora, P.S.** *Departamento de Tecnologia, Quimica e de Alimentos Centro de Tecnologia, Universidade Federal da Paraiba, 58059-900-Joao Pessoa – PB, Brazil*
- Burdon, J.N.** *Post-Harvest Horticultural Group, Crop Utilisation Department, Natural Resources Institute, Chatham Maritime, Kent ME4 4TB, UK. Present address: The Horticulture and Food Research Institute of New Zealand Ltd, Mt Albert Research Centre, 120 Mt Albert Road, Private Bag 92 169, Auckland, New Zealand*
- Chachin, K.** *Department of Plant Science, College of Agriculture, Osaka Prefecture University, 1-1, Gakuen-cho, Sakai, Osaka 593, Japan*
- Cheah, L.H.** *New Zealand Institute for Crop and Food Research Limited, Levin Research Centre, Private Bag 4005, Levin, New Zealand*
- Chessa, I.** *Istituto di Coltivazioni Arboree, Università degli Studi di Sassari, Via E. de Nicola, 07100 Sassari, Italy*
- Coates, L.M.** *Plant Protection Unit, Department of Primary Industries, 80 Meiers Road, Indooroopilly, Queensland 4068, Australia*
- De La Plaza, J.L.** *Departamento Ciencia y Tecnología, de Productos Vegetales, Instituto del Frio, (CSIC), Ciudad Universitaria, 28040 Madrid, Spain*

- García, J.M.** *Departamento de Fisiología y Tecnología de Productos Vegetales, Instituto de la Grasa, CSIC, Avda. Padre Garcia Tejero 4, 41012 Sevilla, Spain*
- Hamauzu, Y.** *Department of Food Production, Faculty of Agriculture, Shinshu University, 8304 Minami-minowa, Kami-ina, Nagano 399-45, Japan*
- Irving, D.E.** *New Zealand Institute for Crop and Food Research Limited, Levin Research Centre, Private Bag 4005, Levin, New Zealand*
- Joshi, G.D.** *Department of Horticulture, Konkan Krishi Vidyapeeth, Dapoli, Maharashtra, India*
- Ketsa, S.** *Department of Horticulture, Faculty of Agriculture, Kasetsart University, Bangkok, Chatuchak 10900, Thailand*
- Lazan, H.** *Department of Botany, Faculty of Life Science, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia*
- Maharaj, R.** *Department of Food Science and Technology, University Laval, Sté Foy, Québec G1K 7P4, Canada*
- Merodio, C.** *Departamento Ciencia y Tecnología de Productos Vegetales, Instituto del Frio, (CSIC), Ciudad Universitaria, 28040 Madrid, Spain*
- Mitra, S.K.** *Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, 741252, Nadia, West Bengal, India*
- Murata, T.** *Shizuoka University, 554-19, Hirashima, Fujieda City, Japan*
- Narain, N.** *Departamento de Tecnologia, Química e de Alimentos, Centro de Tecnologia, Universidade Federal da Paraíba, 58059-900-Joao Pessoa - PB, Brazil*
- O'Hare, T.J.** *Horticulture Postharvest Group, Queensland Department of Primary Industries, 19 Hercules Street, Hamilton, Queensland 4007, Australia*
- Olías, J.M.** *Departamento de Fisiología y Tecnología de Productos Vegetales, Instituto de la Grasa, CSIC, Avda. Padre Garcia Tejero 4, 41012 Sevilla, Spain*
- Paull, R.E.** *Department of Plant Molecular Physiology, University of Hawaii at Manoa, 3190 Maile Way, Honolulu, HI 96822, USA*
- Roy, S.K.** *Division of Fruits and Horticultural Technology, Indian Agricultural Research Institute, New Delhi 110012, India*
- Saks, Y.** *Golan Research Institute, PO Box 97, Qatzrin, 12900, Israel*
- Sankat, C.K.** *Agricultural Engineering Programme, Faculty of Engineering, The University of the West Indies, St Augustine, Trinidad*
- Sean Carrington, C.M.** *Biology Department, University of the West Indies, PO Box 64, Bridgetown, Barbados*
- Tongdee, S.C.** *Thailand Institute of Scientific and Technological Research, 196 Phahonyothin, Chatuchak, Bangkok 10900, Thailand*
- Turner, D.W.** *Plant Sciences, Faculty of Agriculture, The University of Western Australia, Nedlands, Western Australia 6907, Australia*

Underhill, S.J.R. *Horticulture Postharvest Group, Department of Primary Industries, 19 Hercules Street, Hamilton, Queensland 4007, Australia*

Waskar, D.P. *Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India*

Worrell, D.B. *Biology Department, University of the West Indies, PO Box 64, Bridgetown, Barbados. Present address: Sedge Pond, St. Peter, Barbados.*

Preface

There is a growing interest in all areas of tropical and subtropical fruit (production, postharvest and marketing). In the last two decades, production of tropical and subtropical fruits has markedly increased in all the Asian countries, Australia, New Zealand, South Africa, and Japan where they make a significant contribution towards earning foreign currency. Tropical and subtropical fruits present special problems in conservation and transportation because they are much more perishable than temperate tree fruits and because of the long distances between the producing countries and their major export markets. Postharvest horticulture groups working on tropical and subtropical fruits in different countries have made significant contributions in the recent past towards minimizing the postharvest loss by providing information on maturity standards for each fruit, physiological changes in fruit after harvest, storage requirements and storage problems.

This book brings into one volume the most up to date results of research on the postharvest physiology and storage of a large number of tropical and subtropical fruits, and I believe will be a valuable reference for postgraduate students, researchers, development agencies and corporate sector. The book contains contributions from several eminent experts in the field and the editor wishes to express his sincere gratitude to all the contributors for their efforts and perseverance. I hope the book will trigger further research on the physiology and storage of tropical and subtropical fruits especially in those areas identified by the contributors.

The editor wishes to thank the staff members of the Publishing Division at CAB INTERNATIONAL for their substantial help during the process of publication, and the DID for providing funds for the colour illustrations.

S.K. Mitra

Acknowledgements

The publishers would like to acknowledge the assistance of the Department for International Development (formerly Overseas Development Administration, UK) for a contribution towards the cost of including colour photographs in this book.

POSTHARVEST PHYSIOLOGY AND STORAGE OF TROPICAL AND SUBTROPICAL FRUITS

Edited by Sisir Mitra, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur 741252, Nadia, West Bengal, India.

Tropical and subtropical fruits are becoming more important food items in countries where they are produced and also in an increasing number of importing countries in non-tropical zones. For many of the countries where these crops are grown they represent one of the primary ways of earning valuable foreign exchange. In the last few years fruit production in most tropical and subtropical countries of the world has increased substantially, and most of the fruits grown in these regions now have established and growing markets in North America and Europe.

The transport of tropical and subtropical fruits from areas of production to markets in temperate zones raises particular postharvest storage issues, while postharvest losses in the tropics themselves can be considerable. Whilst there are several texts addressing the postharvest needs of temperate fruits, there has not until now been a comprehensive volume dealing with tropical and subtropical fruits. This volume is the first book to deal with the postharvest storage, physiology and conservation of all of the economically important tropical and subtropical fruits. Contributors include leading research workers from throughout the world, including Europe, North, Central and South America, Australia, New Zealand, East and Southeast Asia and the Middle East. The resultant work represents a substantial contribution to this important and fast developing area. The book is essential reading for all horticultural researchers and students working with these crops and for growers, exporters and importers within the industries concerned with tropical and subtropical fruits.

Also Available from CAB INTERNATIONAL

The Mango: Botany, Production and Uses

Edited by R.E. Litz

1997 512 pages ISBN 0 85199 127 0

The Physiology of Vegetable Crops

Edited by H.C. Wien

1997 800 pages ISBN 0 85199 146 7

Cucurbits

R.W. Robinson and D. Decker-Walters

1997 224 pages ISBN 0 85199 133 5

Bananas and Plantains

J.C. Robinson

1996 256 pages ISBN 0 85198 985 3

Citrus

F.S. Davies and L.G. Albrigo

1994 272 pages ISBN 0 85198 867 9

Insect Pests and Fresh Horticultural Products: Treatments and Responses

Edited by R.E. Paull and J.W. Armstrong

1994 368 pages ISBN 0 85198 872 5

Front cover photograph by Nigel Cattlin (Holt Studios International, Hungerford, UK)

ISBN 0 85199 210 2

CAB INTERNATIONAL

Headquarters: Wallingford, Oxon OX10 8DE, UK.

North America: 198 Madison Avenue, New York, NY 10016, USA.

Asia: PO Box 11872, 50760 Kuala Lumpur, Malaysia.

Caribbean: Gordon Street, Curepe, Trinidad and Tobago.

Africa: PO Box 76520, Nairobi, Kenya.

Cover designed by:
S Jayne Clements,
Watkiss Studios Ltd
Biggleswade, Beds