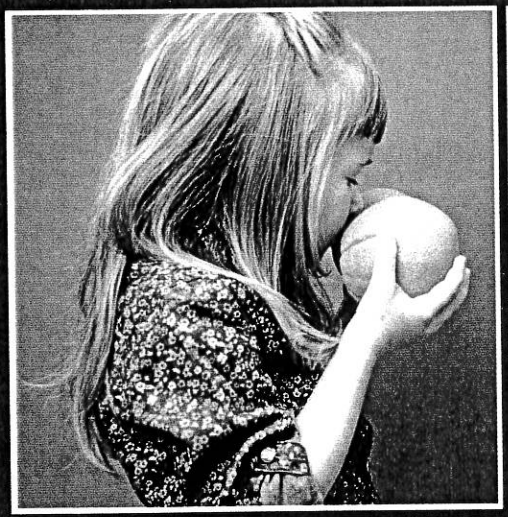
Part Four - Flavor Perception and Physiologial Status

Marie-Christine Lacroix, Nicola Kuszewski, Christine Baly, P. Duchamp-Viret

WOODHEAD PUBLISHING SERIES IN FOOD SCIENCE, TECHNOLOGY AND NUTRITION



Flavor

From Food to Behaviors, Wellbeing and Health

Edited by Patrick Etiévant, Elisabeth Guichard, Christian Salles and Andrée Voilley

Related Titles

Flavour Science: Proceedings from XIII Weurman Flavour Research Symposium
(ISBN 978-0-12398-549-1)

Sensory Evaluation Practices 4th edition
(ISBN 978-0-12382-086-0)

Modifying Flavour in Food
(ISBN 978-1-84569-074-8)

Woodhead Publishing Series in Food Science, Technology and Nutrition: Number 299

Flavor

From Food to Behaviors, Wellbeing and Health

Edited by

Patrick Etiévant
Elisabeth Guichard
Christian Salles
Andrée Voilley

ELSEVIER

AMSTERDAM • BOSTON • HEIDELBERG • LONDON
NEW YORK • OXFORD • PARIS • SAN DIEGO
SAN FRANCISCO • SINGAPORE • SYDNEY • TOKYO
Woodhead Publishing is an imprint of Elsevier

Woodhead Publishing is an imprint of Elsevier
The Officers' Mess Business Centre, Royston Road, Duxford, CB22 4QH, UK
50 Hampshire Street, 5th Floor, Cambridge, MA 02139, USA
The Boulevard, Langford Lane, Kidlington, OX5 1GB, UK

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication Data
A catalog record for this book is available from the Library of Congress

ISBN: 978-0-08-100295-7 (print)
ISBN: 978-0-08-100300-8 (online)

For information on all Woodhead publications
visit our website at https://www.elsevier.com/

Publisher: Nikki Levy
Acquisition Editor: Rob Sykes
Editorial Project Manager: Josh Bennett
Production Project Manager: Caroline Johnson
Designer: Greg Harris

Contents

List of Contributors

Knaapila Antti Department of Biochemistry, Food Chemistry and Food Development, University of Turku, Turku, Finland

Nilüfer Z. Aydınoğlu Koç University, Istanbul, Turkey

Christine Baly NBO, INRA, Université Paris-Saclay, Jouy-en-Josas, France

Loïc Briand Center for Taste and Feeding Behaviour (CSGA), CNRS, INRA, Université de Bourgogne Franche-Comté, Dijon, France

Marie-Claude Brindisi Center for Taste and Feeding Behaviour (CSGA), CNRS, INRA, Université de Bourgogne Franche-Comté, Dijon; Endocrinology, CHU Dijon, France

Laurent Brondel Center for Taste and Feeding Behaviour (CSGA), CNRS, INRA, Université de Bourgogne Franche-Comté, Dijon; Hepato-Gastro-Enterology, CHU Dijon, France

Ilona Croy Smell and Taste Clinic, Department of Otorhinolaryngology, TU Dresden; Department of Psychosomatic Medicine, TU Dresden, Dresden, Germany

Patricia Duchamp-Viret Neuroscience Research Center of Lyon (CRNL), University of Lyon, Lyon, France

Ciarán G. Forde Clinical Nutrition Research Centre (CNRC); Singapore Institute for Clinical Sciences, Agency for Science, Technology and Research (A*STAR); National University of Singapore, Department of Physiology, Yong Loo Lin-School of Medicine, Singapore

Elisabeth Guichard Center for Taste and Feeding Behaviour (CSGA), CNRS, INRA, Université de Bourgogne Franche-Comté, Dijon, France

Antje Haehner Smell and Taste Clinic, Department of Otorhinolaryngology, TU Dresden, Dresden, Germany

Remco C. Havermans Department of Clinical Psychological Science, Faculty of

Thomas Hummel Smell and Taste Clinic, Department of Otorhinolaryngology, TU Dresden, Dresden, Germany

Agnès Jacquin-Piques Center for Taste and Feeding Behaviour (CSGA), CNRS, INRA, Université de Bourgogne Franche-Comté, Dijon; Neurology CHU Dijon, France

E.P. Köster Helmholtz Institute, University of Utrecht, Utrecht, the Netherlands

Nicola Kuszewski Neuroscience Research Center of Lyon (CRNL), University of Lyon, Lyon, France

Marie-Christine Lacroix NBO, INRA, Université Paris-Saclay, Jouy-en-Josas, France

Sandell Mari Functional Foods Forum, University of Turku, Turku, Finland

J. Mojet Wageningen University and Research Centre, Wageningen, the Netherlands

Thomas Mouillot Center for Taste and Feeding Behaviour (CSGA), CNRS, INRA, Université de Bourgogne Franche-Comté, Dijon; Hepato-Gastro-Enterology, CHU Dijon, France

Sophie Nicklaus Center for Taste and Feeding Behaviour (CSGA), CNRS, INRA, Université de Bourgogne Franche-Comté, Dijon, France

Laaksonen Oskar Department of Biochemistry, Food Chemistry and Food Development, University of Turku, Turku, Finland

Luc Pénicaud Center for Taste and Feeding Behaviour (CSGA), CNRS, INRA, Université de Bourgogne Franche-Comté, Dijon, France

Edmund T. Rolls Oxford Centre for Computational Neuroscience, Oxford, United Kingdom

Anne Saint-Eve Microbiology and Food Process Engineering, UMR GMPA, AgroParisTech, INRA, University of Paris Saclay, Thiverval-Grignon, France

Christian Salles Center for Taste and Feeding Behaviour (CSGA), CNRS, INRA, Université de Bourgogne Franche-Comté, Dijon, France

Eda Sayın IE Business School, Madrid, Spain

Benoist Schaal Center for Taste and Feeding Behaviour (CSGA), CNRS, INRA, Université de Bourgogne Franche-Comté, Dijon, France

Charlotte Sinding Center for Taste and Feeding Behaviour (CSGA), CNRS, INRA, Université de Bourgogne Franche-Comté, Dijon, France

Richard J. Stevenson Department of Psychology, Macquarie University, Sydney, NSW, Australia

Thierry Thomas-Danguin Center for Taste and Feeding Behaviour (CSGA), CNRS, INRA, Université de Bourgogne Franche-Comté, Dijon, France

Carole Tournier Center for Taste and Feeding Behaviour (CSGA), CNRS, INRA, Université de Bourgogne Franche-Comté, Dijon, France

Anne Tromelin Center for Taste and Feeding Behaviour (CSGA), CNRS, INRA, Université de Bourgogne Franche-Comté, Dijon, France

Hoppu Ulla Functional Foods Forum, University of Turku, Turku, Finland

Dominique Valentin Center for Taste and Feeding Behaviour (CSGA), CNRS, INRA, Université de Bourgogne Franche-Comté, Dijon, France

Metabolic status and olfactory function

14

Marie-Christine Lacroix, Nicola Kuszewski**, Christine Baly*, Patricia Duchamp-Viret***

*NBO, INRA, Université Paris-Saclay, Jouy-en-Josas, France; **Neuroscience Research Center of Lyon (CRNL), University of Lyon, Lyon, France

14.1 Olfactory function is under the influence of metabolic-related hormones and peptides, as well as of nutriments: neuroanatomical evidences

For 50 years, numerous efforts have been done to localize hormones/peptides and their receptors by immunohistochemistry, radioimmunoassay, radioactive or not, hormone binding assays and, more recently, molecular biology. The demonstration that most metabolic anorexigenic and orexigenic hormones and peptides receptors traditionally considered to be feeding-related are expressed in the olfactory system in many species came strongly to support the findings that odor processing can be modulated by the nutritional status; this especially in the first two levels of the olfactory system, the olfactory mucosa (OM) and the olfactory bulb (OB), and thus well before the involvement of cortical integration (Martin et al., 2009; Palouzier-Paulignan et al., 2012; Lucero, 2013).

14.1.1 *Anatomical distribution of receptors to metabolic-related hormones and peptides along the olfactory pathways*

14.1.1.1 Olfactory mucosa

In the mammalian OM,[a] mature olfactory sensory neurons (OSNs), the key cells interacting with odorant molecules and transducing the odorant signal, express a large array of receptors related to major anorexigenic or orexigenic metabolic hormones: orexin receptor (OXR) that have been localized in the apical ends of the sensory neurons (Caillol et al., 2003; Gorojankina et al., 2007), leptin receptor (Ob-R) (Baly et al., 2007) and insulin receptor (IRs) (Lacroix et al., 2008) in dendritic knobs, ghrelin receptor (Ghsr1a) (Loch et al., 2015), and endocannabinoid receptor CB1 in mature OSN (Hutch et al., 2015). To a lesser extent, neuropeptide Y receptor (NPY-Y1R) is expressed in a subset of OSNs dispersed within the OE (Negroni et al., 2012).

[a] The olfactory mucosa is located in the upper region of the nasal cavity, and is made up of the olfactory epithelium (OE) and the underlying *lamina propria*, connective tissue containing fibroblasts, blood vessels, Bowman's glands, and bundles of fine axons from the olfactory neurons.