

*Enterobacter  
sakazakii*

## **Emerging Issues in Food Safety**

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# *Enterobacter sakazakii*

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Cover illustration: *Enterobacter sakazakii* attached to an enteral feeding  
tube. (Courtesy of Stephen J. Forsythe.)

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## Series Editor's Foreword

*Enterobacter sakazakii* emerged as a major concern for manufacturers of infant formula because of its association with deaths of infants, largely premature or in intensive care units (ICUs), fed contaminated, reconstituted powdered infant formula that was typically temperature abused in ICUs. For these infants, the mortality rate was high, ranging from 40 to 80%. Since its recognition as a severe pathogen for specific high-risk populations, a wealth of information regarding the detection, ecology, survival characteristics, and pathogenicity of *E. sakazakii* has been generated.

Jeffrey Farber and Steve Forsythe, two leaders in studying the food-associated aspects of *E. sakazakii*, have combined forces with many internationally recognized *E. sakazakii* experts to provide an impressive compilation of the state-of-the-science surrounding this pathogen. Topics that are addressed include taxonomy, isolation and identification, epidemiology, pathogenicity, production and use practices of infant formula that influence *E. sakazakii* contamination and growth, and regulatory issues. I know of no other source that provides as much relevant, up to date information on the food safety aspects of *E. sakazakii* than this book. It is an invaluable resource for those of us interested in the microbiological safety of foods.

MICHAEL P. DOYLE, Series Editor  
*Emerging Issues in Food Safety*

## Preface

*Enterobacter sakazakii* is an emerging opportunistic pathogen that has caused much concern in the food industry, as well as in regulatory and academic communities. In fact, there has been more work done in the last 2 to 3 years than in the past 25 years. As an example, in the last 2 years alone there have been at least 85 publications on this organism.

Our experience indicated that there was no single source that had all the up-to-date information on this very unique pathogen. Thus, we have set out to compile the latest information on *E. sakazakii*, all under one cover.

This bacterium is unique in the sense that it is widespread in the environment and for the most part affects only a small subset of the population, i.e., infants under 1 year of age, although cases do occur in adults and the incidence of disease caused by this organism is underreported. It also survives the drying process very well and thus can be found in dry food products such as skimmed milk powder, lactose, starch, lecithin, orange powder, and banana powder, all ingredients that can be added to powdered infant formula. In addition, because the organism affects the youngest and most vulnerable segment of our population, the issue has been raised to the highest levels of attention and effort.

As mentioned above, the research community has made great strides in almost all areas associated with the biology of this organism. In addition, the powdered infant formula industry has done a tremendous job in reducing the incidence of contaminated formulae in the marketplace. Advances in methodology have been quite dramatic, and we are now able to more readily detect this organism than ever before. However, advancements will still need to be made to detect the increasingly lower levels of this organism that we will see in the future in powdered infant formula. There are various collaborative studies under way, and these will help to further advancements in this area. One can also already see rapid advances being made in understanding

the pathogenesis of this organism, and in this area we think there will be tremendous progress.

At the international level, attention also has been drawn to this issue, and two major risk assessment meetings have taken place, which have resulted in two publications. In the Codex Alimentarius, the Committee on Food Hygiene (CCFH) has been involved in terms of trying to draft a revised document on hygienic practices for powdered formulae for infants and young children, which is currently at Step 3 in the Codex process. In addition, WHO has recently published a guidance document for the safe preparation, storage, and handling of powdered infant formula.

In the next 5 to 10 years, our understanding of this organism and how and why it causes human illness will increase dramatically, and regulatory agencies will be able to use the outputs of this information to devise better risk management strategies that are based on sound science. For example, bacterial taxonomy is being revolutionized by the use of DNA sequence analysis, which may not always agree with past divisions according to sugar fermentation profiles, etc. The family *Enterobacteriaceae* originally was defined according to such phenotyping, and therefore the application of DNA sequence analysis is revising our perspective of this family. The genus *Enterobacter* is comprised of a phenotypically diverse group of bacteria, and thus it is not surprising that it has been recently proposed that *E. sakazakii* actually should be taken out of the genus *Enterobacter* and placed into a new genus, "*Cronobacter*," consisting of four new species and one genomospecies. All the species would still be considered pathogenic for neonates. Thus, from a regulatory point of view, not much would change. However, in the future, if the proposed nomenclature changes are accepted, this may allow us to more specifically target the species of concern. For example, if we find out that there are differences in virulence in some of the new species, different microbiological criteria possibly could be set. Work in this area also could lead to the identification of other members of the *Enterobacteriaceae* that are able to cause disease in infants when present in sufficient numbers in powdered infant formula.

This book, which we trust you will enjoy, hopefully will be a useful reference tool for many years to come for regulators, industry members, and academics who are interested in this organism or who are involved in some way with powdered infant formula used for the feeding of infants.

JEFFREY M. FARBER  
STEPHEN J. FORSYTHE

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