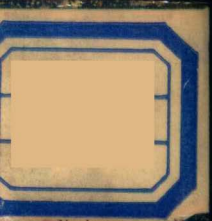


MICRONUTRIENTS IN MILK AND
MILK-BASED FOOD PRODUCTS

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MICRONUTRIENTS IN MILK AND MILK-BASED FOOD PRODUCTS

Edited by

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AND MILK-BASED FOOD PRODUCTS

Interest in the nutritional significance of minerals, trace elements and vitamins has shown a marked increase in recent years. This can be explained by the technical progress in analytical and clinical chemistry which has provided the basis for accurate measurement of these components and for a better understanding of their impact on metabolism.

This book, edited by a prominent dairy scientist, deals with factors affecting the concentration of micronutrients and their chemical, nutritional and technological aspects in milk and milk-based products. Vitamins, trace elements, organic acids and hormones (or hormone-like substances) are genuine micronutrients in cows' milk. Fractions belonging to the lipid, protein, and carbohydrate groups are present in such low concentrations that they may also be considered as micronutrients. With regard to most of the other micronutrients only a limited knowledge is available concerning their nutritional significance, however, particular importance is attributed to many of them in the nutrition of infants. Therefore, two chapters in this book are devoted to micronutrients in human milk and in infant formulas.

The processing and storage of milk and milk-based food products is discussed, and whether as a result of this micronutrients undergo change or new substances appear which exhibit a nutritional impact. *Micronutrients in Milk and Milk-Based Food Products* provides an up-to-date reference source for a fascinating group of nutrients in milk, which are present only in microconcentrations, but which apparently have major nutritional importance. This volume will be of interest to dairy and food scientists and technologists as well as food analysts and technologists.

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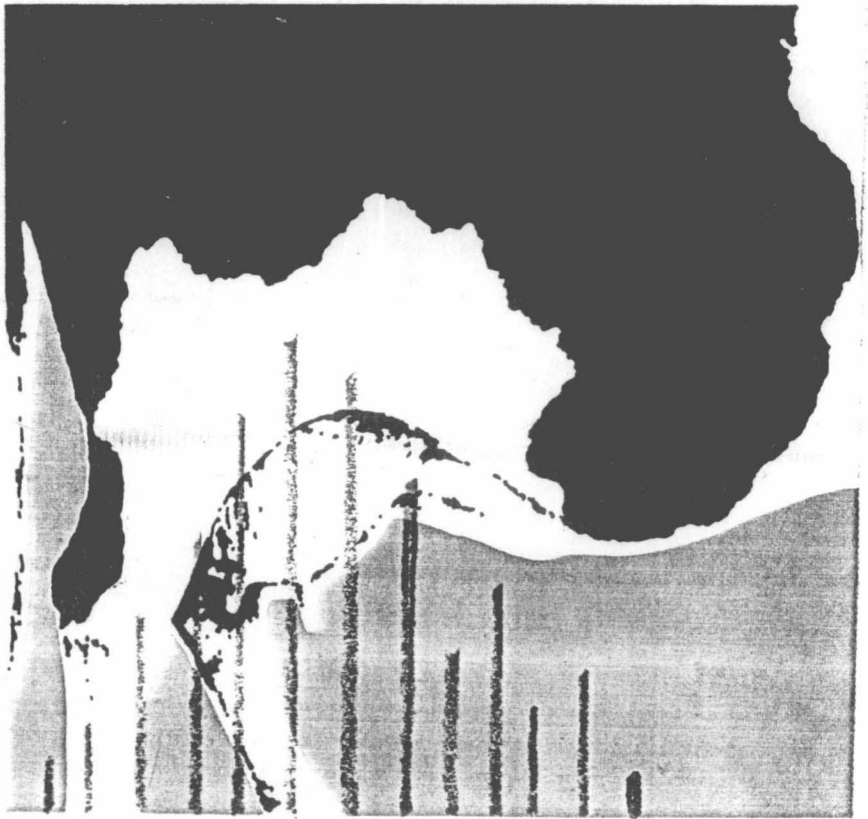


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Edited by E. RENNER



ELSEVIER APPLIED SCIENCE

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**MICRONUTRIENTS IN MILK
AND MILK-BASED FOOD PRODUCTS**

PREFACE

Since it has been suggested that components in milk should only be considered to be micronutrients when their concentration is not higher than 1 g per kg of milk, it becomes evident that vitamins, trace elements, organic acids (although citric acid is present at a higher concentration) and hormones (or hormone-like substances) are genuine micronutrients in cows' milk. Amongst the minerals, only calcium and potassium exceed this threshold value, therefore minerals also can be attributed to the micronutrient group — especially since the content of all minerals in human milk is below this limit.

Certainly, protein, fat and lactose (as the carbohydrate of milk) are macronutrients. But these substances do not at all occur as uniform compounds, therefore fractions belonging to the lipid, protein and carbohydrate groups are present in such low concentrations that they have to be considered as micronutrients too:

- Amongst the lipids, it is mainly phospholipids that belong to the group of micronutrients, but free fatty acids, cerebrosides, and cholesterol also belong; certainly some of the minor fatty acids in the triglycerides have to be considered too, particularly essential fatty acids.
- There are a wide variety of proteins in milk occurring in low concentrations, including immunoglobulins, lactoferrin and other minor proteins, and some specific free amino acids like taurine; and the fractions of non-protein nitrogen should also not be neglected.
- When lactose was called 'the forgotten carbohydrate', that meant that nowadays the nutritional significance of lactose is increasingly being recognized, but what about the monosaccharides, oligosaccharides, etc., in milk as micronutrients?

Two aspects have to be dealt with as far as processing and storage of

milk and milk-based food products are concerned. Do micronutrients undergo changes? And, if new substances appear, for instance, from the Maillard reaction or from ripening procedures, do they exhibit a nutritional impact and, therefore, do they have to be regarded as micronutrients too?

In particular, interest in the nutritional significance of minerals, trace elements and vitamins has markedly increased in recent years. This can be explained by the technical progress in analytical and clinical chemistry which has provided the basis for accurate measurement of these components and for a better understanding of their impact on metabolism. As a result, well-founded recommended dietary allowances could be established which permit the evaluation of the contribution of milk and other foods to the supply of these nutrients.

With regard to most of the other micronutrients, only limited knowledge is available concerning their nutritional significance. However, particular importance is attributed to many of them in the nutrition of infants. Therefore, two chapters in this book are devoted to micronutrients in human milk and in infant formulas.

It is intended that the book should provide an up-to-date reference source for this fascinating group of nutrients in milk, which are present only in microconcentrations, but many of which apparently have major nutritional importance. It has already been mentioned that there are major gaps in our knowledge — perhaps this book will help to stimulate scientists to fill these gaps.

I wish to thank sincerely the other authors for their excellent contributions, and for their greatly appreciated co-operation which made my task as editor very enjoyable.

E. RENNER

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Chapter 1

Micronutrients in Milk

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1.1 Lipids as micronutrients

1.1.1 Minor lipids in milk

In milk 98–99% of the lipids are triglycerides located in the fat globule. The remaining 1–2% are minor lipids with the following components: diglycerides 0.3–1.6%, monoglycerides 0.002–0.1%, phospholipids 0.2–1.0%, cerebrosides 0.01–0.07%, sterols 0.2–0.4%, free fatty acids 0.1–0.4% (Renner, 1983). Hydrocarbons, sterolesters, waxes and squalen are found only in traces. Furthermore, the fat soluble vitamins can be considered as minor lipids (see Section 1.5).

1.1.2 Phospholipids

Milk contains phospholipids at a concentration of 20–50 mg/100 ml. The content depends on the type of feed and the season (Christie *et al.*,

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