IOCCC (1988) *Determination of Moisture (Karl Fisher Method)*. IOCCC 26, IOCCC, London.

IOCCC (1988) *Determination of the "Blue Value"*. IOCCC 29, IOCCC, London.

IOCCC (1990) *Determination of Fat Content of Cocoa Powder by Soxhlet Extraction*. IOCCC 37, IOCCC, London.

IOCCC (1990) *Microbiological Examination of Chocolate and other Cocoa Products*. IOCCC 39, IOCCC, London.

IUPAC (1987). *Determination of the Refractive Index of Animal and Vegetable Oils and Fats*. IUPAC 2.102, IUPAC, London

IUPAC (1987) *Determination of the Acid Value (A.V.) and the Acidity of Animal and Vegetable Oils and Fats*. IUPAC 2.201, IUPAC, London

IUPAC (1987) *Determination of the Iodine Value (I.V.) of Oils and Fats*. IUPAC 2.205, IUPAC, London

IUPAC (1987) *Determination of the Unsaponifiable Matter in Oils and Fats*. IUPAC 2.401, IUPAC, London

Gill, O.N., Sockett, P.N., Bartlett, C.L.R. *et al.* (1983) Outbreak of *Salmonella napoli* infection caused by contaminated chocolate bars. *Lancet*, **12**(1), 574–577.

Kleinert, J. (1972) *International Chocolate Review*, **27**, 379.

Knezevic, G. (1983) Über den metallgehalt in kakobohnen- und schalen, *Zucker und Süsswaren Wirtschaft*, **17**, 319–320.

Mohr, W., Ziegleder, G., Lehnert, H., (1978) Über die Grundlagen der Aromaveredelung von milchfreien und milchhaltigen Schokoladen- massen. *Zucker und Süsswaren Wirtschaft*, **12**, 425–430.

Richardson, T. (1982) Cocoa: alkalised, dutched, natural and black. *Manufacturing Confectioner*, **62**(10), 50.

Schenkel, H.J. (1973) Color formation in the Dutch processing of cocoa. *Manufacturing Confectioner.* **53**(8), 26.

Taneri, C.E. (1977) Cocoa liquor Dutching. *Manufacturing Confectioner*, **57**(9), 57.

Ziegleder, G., Oberparleiter, S. (1996) Aromaentwicklung in Kakao durch feucht-thermische, *Behandlung II, Süsswaren*, **10**, 60–63.

CHAPTER 4
Sugar and bulk sweeteners

Christof Krüger

4.1 Introduction

Sugar is a sweet-tasting crystallised saccharide extracted from sugar cane or sugar beet. Both the beet and the cane produce an identical natural substance, which is chemically termed "sucrose" or "saccharose". Sugar cane has been grown in Melanesia, India and China since prehistoric times. The discovery of sucrose in the beet plant *Beta vulgaris* was made in Prussia in the eighteenth century. The first method of extracting the sucrose from beet was developed by Franz Karl Achard, the director of the Academy of Sciences in Berlin, at the end of the eighteenth century. In 1799 this was even considered by the author of a scientific publication as "the most important discovery of the eighteenth century" (Bruhns, 1997).

Sucrose is a disaccharide composed of the chemically linked monosaccharides glucose and fructose. This linkage, however, may be cleaved hydrolytically by acids or by the enzyme invertase (β-D-fructofuranosidase). The resulting mixture consists of equal parts of glucose and fructose and is called invert sugar.

A great many other saccharides also exist, such as the monosaccharides glucose (dextrose) and fructose, the disaccharide lactose and sugar alcohols, for instance sorbitol and xylitol. For the production of chocolate, sucrose is by far the most important sugar. With the increasing demand for low calorie, reduced glycaemic index or tooth-friendly products, however, other sweeteners are becoming more widely used.

4.2 The production of sugar

For the production of beet sugar, the beets, which contain about 14–18% sucrose, are cleaned and cut into slices. These are then extracted in hot water by counterflow processes. Together with the sugar, mineral and organic substances from the beet find their way into the raw juice produced. Since these non-sugar substances strongly inhibit crystallisation of the sugar, the solution must be purified. This is

Beckett's Industrial Chocolate Manufacture and Use, Fifth Edition. Edited by Stephen T. Beckett, Mark S. Fowler and Gregory R. Ziegler.