Isothermal Crystallization Kinetics of Cocoa Butter as observed by Hot Stage Microscopy in Conjunction with Image Analysis

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Cocoa Butter is one of the most popular and widely used raw materials in the chocolate and confectionery industry due to its unique melting characteristics and physical properties. It contributes to the delicate texture and mouthfeel experienced in a chocolate. Crystallization of cocoa butter is very important as it influences the overall characteristics of a product. Hence the crystallization and polymorphic behaviour of cocoa butter has been of keen interest and extensively studied by many for a long time. However the application of imaging techniques to monitor whole crystallization growth history of individual cocoa butter crystals over time is limited. In this study, Hot Stage Microscopy is used to visualise the nucleation, growth and morphology of cocoa butter crystals from the melt, analyzed by a novel image processing algorithm previously developed by this group.

Isothermal crystallization of cocoa butter was carried out under static conditions at temperatures of 20°C to 23.5°C at an interval of 0.5°C. Crystals of different morphologies, such as ‘bow-tie’ and ‘feathery’ shaped spherulites were observed during the various isothermal temperatures. However with increasing temperature the crystal morphologies tended to have a better defined structure and were more regular in shape. The growth rate of the crystals was found to decrease exponentially with time, which is likely to be due to the exhaustion of crystallisable material in the liquid phase. As anticipated, the solid fat content was also found to decrease with increasing temperatures. The growth rates of the crystals varied mildly as a function of temperature but appeared to vary from crystal to crystal and even between different sides of the same crystal, probably due to variations in composition within the liquid phase. Nucleation rates were found to vary approximately exponentially with decreasing temperature, producing much greater numbers of crystals and a smaller final average crystal size at lower temperatures.