Application note No.11-002 2019-03-25

Differential Scanning Calorimeter

# Thermal analysis of Chocolate

Chip-DSC 10

## Introduction

In food production and food investigation due to health studies, the thermal analysis becomes more and more important. Especially carbon and fat content of various products is very often target of analytical interests. Another very interesting application for DSC is the analysis of chocolate. It helps to investigate the melting behavior, melting temperature and fat content of different mixtures and therefore it is crucial for the design of a tasty, creamy product.

## Methods

Using a DSC for analyzing foods and organics is a more or less common technique. In this application, the new Chip-DSC 10 was used for measurements of different chocolates.

The DSC signal in general is generated by heating a sample containing pan and an empty reference pan with the same heat source and subtracting the heat flow signals of the two pans from each other, resulting in endothermic or exothermic peaks if the sample temperature changes due to thermal effects.

The Chip-DSC 10 integrates all essential parts of DSC: furnace, sensor and electronics in a miniaturized housing. The chip-arrangement comprises the heater and temperature sensor in a chemically inert ceramic arrangement with metallic heater and temperature sensor.

Therefore, the Chip-DSC 10 allows a very fast heating and cooling speed combined with high resolution and accuracy as well as reproducibility.

The result of a DSC measurement can be used as a fingerprint model for substance identification in quality control but can also be used to determine enthalpies of effects like phase transitions.

**Table 1. Experimental Conditions**

| | |
|---|---|
| Instrument | Chip-DSC 10 |
| Heating rate | 20 K/min |
| Sample Mass | 20mg |
| Sample Pan | Aluminum pan |
| Purge Gas | Air |

## Results

Figure 1 shows DSC profiles of five different chocolate samples. Each sample was precooled with liquid nitrogen to -40°C and then measured using the same conditions and similar sample mass.

Chocolate basically consists of a mixture of fat, sugar and cocoa. Additionally emulsifiers are added to create a homogenous melt that ensures the chocolate is not melting when it is touched but it melts when put in mouth, resulting in a creamy feeling and aromatic taste. So the quality of chocolate is dependent on the melting temperature and shape of melting peak. In this experiment, three hard chocolates from Easter bunny figures were compared to white and black cream chocolate.

The result shows that nearly all tested chocolates show a double peak that is caused by low melting milk fats and higher melting plant fats. The purple curve of the handmade milk chocolate shows a very narrow melting peak at 28.5°C, which means that it has a narrow melting range and almost all contained fats form a good emulsion. The cheaper industrial milk chocolate (blue curve) however shows a much broader peak at nearly the same onset temperature. This is more or less comparable to a two-component chocolate like the red curve that displays a black-white chocolate mix. The two low melting cream chocolates (black and green curves) in contrast start to melt at around 15°C and show also a clear gap between the low melting milk fats that make the cream part here and the more solid hull part, melting at around 35°C.

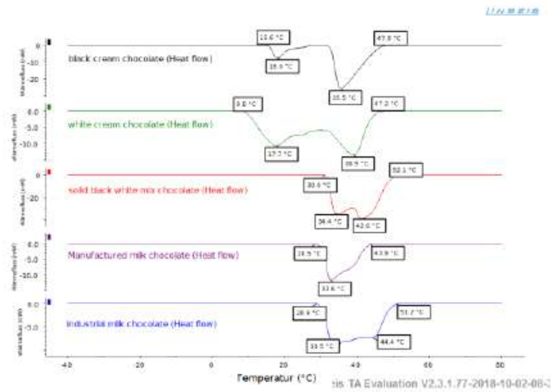


Fig.1 DSC Heat Flow curves of five different chocolaes, Heating rate 20 K/min

## Experimental

All samples were obtained from a local food supplier. Samples were used as provided and measured directly using a Chip-DSC 10 with quench-cooler. All samples were cooled with liquid nitrogen to -40°C before they were measured. The experimental setup is given in table 1.

## Summary

The melting behavior of chocolate can be analyzed very easily using the Chip-DSC 10. The quality of emulsifiers and melting temperature can be compared and used for QC and product design. In this example, the handmade chocolate shows a much more homogeneous melting behavior than cheaper industrial chocolate.

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