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Evaluation of Thermal Behavior of Sweetener Through DSC Coupled to a Photovisual System

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Abstract: The calorimetric curves of sweetener, standards and aspartame/lactose mixtures indicated displacement of transition temperatures in sweetener for smaller temperatures, decreasing the thermal stability. The images in the photovisual system confirmed the displacement of transition temperatures in sweetener and binary mixtures. The brown coloration in smaller temperatures has suggested interaction of aspartame with lactose similar the Maillard's reaction. These techniques allow a rapid evaluation of possible interactions between raw material and excipients.

Key words: Aspartame, calorimetry, photovisual system, interactions, thermal behavior, evaluation

INTRODUCTION

The artificial sweetener aspartame has sweet 180-200 times of sucrose. It is important to study the thermal behavior of foodstuffs because the kinetic factors, temperature and time can provoke decomposition of components with formation of harmful compounds (Vieira and Fatibello, 1995).

Due to technological improvement and better understanding, thermal analysis is rapidly becoming a powerful tool in the arsenal of techniques that is currently available to the analytical chemist (Souza *et al*., 2002; Tavares *et al*., 2002).

Thermal analysis includes all methods, which measure some parameters and its dependence on temperature while heating a sample. The differential scanning calorimetry has a wide range of applications, such as: gelatinization, thermal stability, kinetic study of foodstuffs, polymorphism, purity, interactions of pharmaceutical, etc (Conceição *et al*., 2002; Silva *et al*., 2001; Santos *et al*., 2002; Macêdo *et al*., 2000; Bucci *et al*., 2000).

The differential scanning calorimetry coupled to a Photovisual System accompanies events that occur in the sample in real time of analysis (Souza *et al*., 2002; Macedo and Nascimento, 2002). In this research had been studied the thermal behavior of sweetener and your interactions with excipients through differential scanning calorimetry coupled to a photovisual system.

MATERIALS AND METHODS

Sweetener tablets were acquired in local market. The sweetener contains aspartame as sweetening agent and lactose as diluent agent.

The binary mixtures for the aspartame and diluent were prepared in the proportions of 1:3, 3:1 and 1:1.5 (same proportion of the sweetener) sieved in a 100 mesh screen and homogenize the powders.

Calorimetric measurements: The thermogravimetric curves were obtained in a TGA-50 Shimadzu Thermobalance, under air atmosphere with flow of 20 mL min^{-1}, mass of 2 mg, heating rate of 10°C min^{-1} up to a temperature of 500 °C.

The calorimetric curves were obtained in a DSC-50 Shimadzu Differential Scanning Calorimeter, under nitrogen atmosphere with flow of 50 mL min^{-1}, mass of 2 mg, heating rate of 10 °C min^{-1} up to a temperature of 500 °C.

The calorimeter was coupled to a photovisual system constituted of a VCC-D520 Sanyo Camera connected to an Olympus Microscope. The images were captured by DSC coupled to the photovisual system at a similar temperature and time compared to the conventional DSC.

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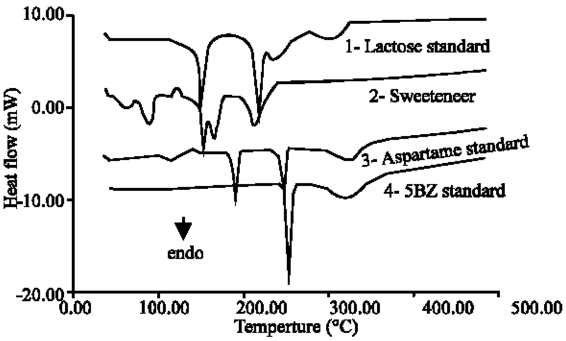

Fig. 1: DSC curves of standards

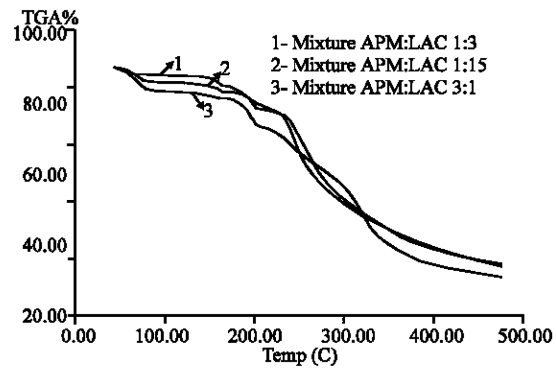

Fig. 2: TG curves of mixtures

RESULTS AND DISCUSSION

The calorimetric curve of aspartame standard (Fig. 1) indicated 5 endothermal transitions and 1 exothermal transition corresponding at dehydration (23-53; 89-124°C) exothermic peak of recrystallization (132-140°C), decomposition of aspartame with volatilization of methanol (170-197°C), fusion of 5-benzyl-3.6-dioxo-2-piperazineacetic acid (product of thermal conversion of aspartame, 247-255°C) and decomposition (290-348°C).

The calorimetric curve of 5-Benzyl-3.6-dioxo-2-piperazineacetic acid (5BZ) standard indicated two endothermal transitions corresponding at fusion (252-260°C) and decomposition (289-357°C).

The calorimetric curve of lactose standard indicated four endothermal transitions and one exothermal transition corresponding at dehydration (131-155°C), exothermic peak of mutarotation (174°C), fusion (203-224°C) and decomposition (225-255°C; 283-329°C).

The calorimetric curve of sweetener indicated 5 endothermal transitions and 1 exothermal transition

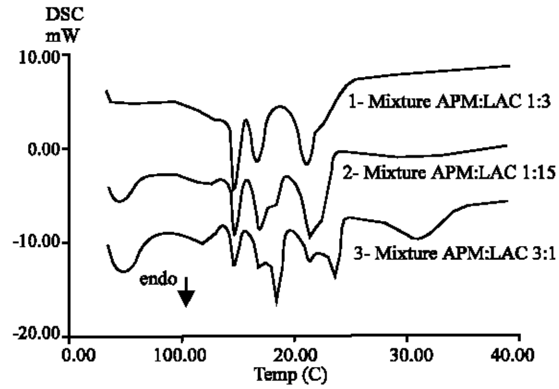

Fig. 3: DSC curves of mixtures

corresponding at dehydration (34-60°C; 64-87°C), exothermic peak of recrystallization of aspartame 106-119°C), lactose dehydration (138-152°C), decomposition of aspartame with volatilization of methanol (152-171°C) and lactose fusion (196-229°C).

Thermogravimetric curves of the binary mixtures Aspartame (APM)/Lactose (LAC) showed displacement of thermal decomposition reactions for smaller temperatures (Fig. 2).

The calorimetric curves of mixtures confirmed displacement of transition temperatures in sweetener for smaller temperatures, indicating interaction of sweetening (aspartame) and diluent (lactose) agents. In the mixture APM:LAC 1:3 possibly formed eutectic mixture (Fig. 3).

Calorimetric studies with the DSC coupled to the photovisual system shows the pictures of samples in which the physical and chemical changes as a function of the temperature were observed.

The aspartame presented bubbles due volatilization of methanol and 5 benzil fusion with change coloration at 245°C (yellow) and 330°C attributed at decomposition of 5benzil with contraction of volume. The 5benzil presented similar change of coloration. The lactose changed coloration at 225 and 250°C attributed at fusion and decomposition with increase of volume. The sweetener changed coloration at 155°C (yellow) and 195°C (brown) attributed at aspartame decomposition and lactose fusion (Fig. 4).

The brown coloration in smaller temperatures has suggested interaction of aspartame with lactose similar the Maillard's reaction. The images in the photovisual system confirmed the displacement of transition temperatures in sweetener and aspartame/lactose mixtures (Fig. 4 and 5).

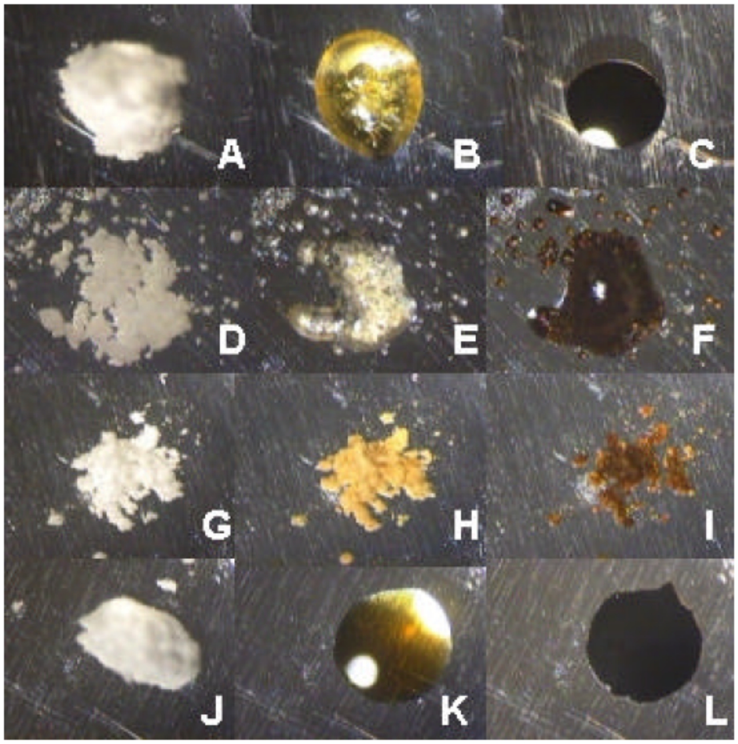

Fig 4: Photos A (25°C), B (245°C) and °C (330°C) of aspartame standard; D (25°C), E (225°C) and F (250°C) of lactose standard; G (25°C), H (155°C) and I (195°C) of sweetener; J (25°C), K (260°C) and L (350°C) of 5benzil standard

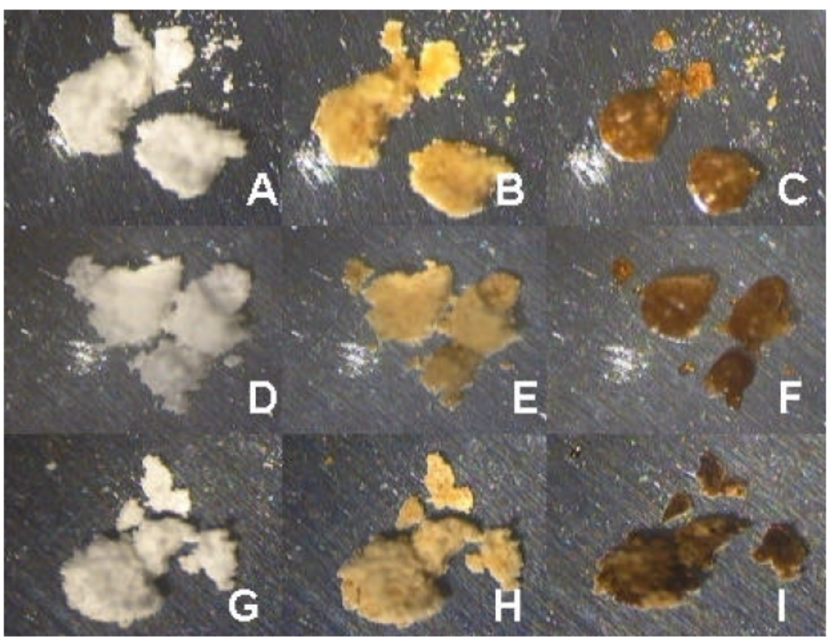

Fig 5: Photos A (25°C), B (150°C) and °C (170°C) of mixture APM:LAC 1:3; D (25°C), E (154°C) and F (76°C) of mixture APM:LAC 1:1,5; G (25°C), H (160°C) and I (180°C) of mixture APM:LAC 3:1

CONCLUSION

The results obtained by scanning differential calorimetry and DSC coupled to a photovisual System of sweetener indicated interaction of aspartame with lactose decreasing the thermal stability. These techniques have demonstrated a better understanding of thermal process in foodstuffs products and a rapid evaluation of possible interactions between raw material and excipients.

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