Deliquescence and deliquescence lowering of food ingredients and blends

– Application Note 20-03

Introduction

Deliquescence describes the transition from a solid to a dissolved state if a critical, material specific relative humidity is exceeded. Deliquescent materials are mostly crystalline and highly water soluble [1].

Deliquescence leads to physical and chemical changes of the product. These may result in caking, decreased solubility and bioavailability, change of appearance and sensory characteristics as well as in a degradation of valuable ingredients like vitamins [2].

In mixtures of such substances the effect of deliquescence lowering can be observed frequently, i.e. dissolution at a relative humidity below the deliquescence point of the individual components [3].

Due to the associated loss of product quality, knowledge of the deliquescence behavior is mandatory to draw conclusions about shelf life and to be able to specifically adapt the recipe. Same applies for pharmaceuticals to guarantee the efficacy of the formulation [4,5].

Principle of the method

Deliquescence points of food ingredients (RH_0) and their mixtures ($RH_{0,mix}$) were determined by DVS – dynamic water vapor sorption – analysis. Measurements were performed in a SPS-1µ (proUmid GmbH, Ulm) at 25 °C. In the relevant region for deliquescence, RH was increased by 1 % steps.

In Fig. 1 sorption isotherms of deliquescent food powders and their blends are shown. At RH's below RH_0 only little moisture is adsorbed. With exceeding the critical RH a steep weight increase can be seen. Deliquescence points RH_0 and $RH_{0,mix}$ were defined as starting point of the steep weight increase.

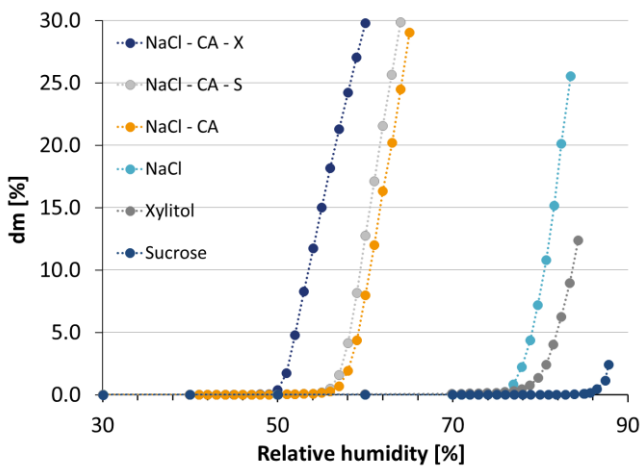

Fig. 1: Water vapor adsorption and onset of deliquescence of individual and mixed ingredients. (NaCl: sodium chloride, CA: citric acid anhydrous, X: xylitol, S: sucrose)

Conclusion

DVS measurements were used to determine deliquescence points of some typical food ingredients and blends. The problems associated with deliquescence are relevant not only to the food- but also to pharma- and chemical industries which makes this method useful in R&D and QA of many industrial sectors.

Fig. 1 shows that the RH0 of food ingredients can differ considerably. Furthermore, the effect of deliquescence lowering in blends consisting of several deliquescent materials can be seen.

Results show that DVS measurements are well suited to accurately determine the onset of deliquescence of different materials. Additionally, the multisampling capacity of the SPS devices provides not only a precise but also a time-saving option.

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