Study of the physical changes of spray-dried inulin during storage

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Abstract

Inulin is a storage oligosaccharide belonging to the family of fructans which, after starch, is the most abundant non structural carbohydrate found in nature.
During the last fifteen years, inulin and its derivatives have received considerable interest as food ingredients under the generic name of oligofructose. Oligofructose is used as a nondigestible dietary fiber and for its bifidogenic and texturing properties in many foodstuff preparations such as milk products, low fat products, bread and drinks. With its use in constant increase, a strong knowledge of inulin is required for technological and formulating purposes. For this reason, a fundamental study correlating the physical properties in a solid state and storage conditions has been done.
The most stable form for the commercialisation of inulin is the powdered form, which has the advantage of facilitating manipulation, transport and storage. However, when a food product is exposed to a certain relative humidity, it loses or gains water to adjust its moisture to equilibrium with the environment conditions.
In this study, we have established by varying the moisture content (MC), a correlation between the caking of inulin and physical parameters, such as crystallinity or glass transition temperature (Tg). Inulin was initially stored for 3 weeks over P_2O_5 or KNO_3 in order to obtain a dehydrated or humidified product. MC was then modified using six different relative humidity storage conditions (P_2O_5, LiCl, $MgCl_2$, NaBr, NaCl and KNO_3). This last storage lasted at least five weeks at 20°C. The adsorption and desorption isotherm were drawn by plotting the MC to the water activity (a_w) of inulin. These isotherms were successfully fitted to the Guggenheim - Anderson - de Boer (GAB) model, to obtain intermediate curve values. The GAB equation was found to adequately represent the experimental data, as the relative percentage Root Mean Square (RMS) was 3.44 and 4.37% for adsorption and desorption isotherm respectively.
The increase of the water moisture above a_w=0.56 decreased the Tg under the storage temperature (20°C) and lead to a development of crystallinity between the amorphous particles, confirmed by static Wide Angle X-ray Scattering (WAXS) and Modulated Differential Scanning Calorimetry (MDSC). Moreover, observation with an Environmental Scanning Electron Microscopy (ESEM) showed the development of some crystal structure among the amorphous system.
These observations have led to an understanding of the physical characteristics of inulin related to the water moisture, which is necessary for the industrial processing and use of this prebiotic ingredient.