Water sorption properties of malt bagasse as essential information for byproduct stabilization and further conversion into high value-added materials

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Brewer's spent grain (BSG) has showed growing interest as a sustainable source of plant-based proteins, but also serving as raw material for second generation bioethanol production – both applications aiming at the circular economy. However, because it presents high water activity at the end of the brewery processing, the determination of its water sorption isotherms and thermodynamic properties becomes necessary under simulated storage and drying conditions. Firstly, BSG were chemically characterized to be, then, subjected to the static gravimetric method in order to experimentally obtain the water adsorption isotherms at ten temperatures (5–90 °C). BSG showed high contents of proteins (>21.4%) and fermentable matter (>44%), confirming the initial applications purposes. Once the sorption isotherms were determined, the Guggenheim-Anderson de-Boer (GAB) model could be adequately fitted to the experimental data (R2adj>0.9928 e Chi-square?0.0001). At temperatures from 5 to 50 °C (storage conditions), the adsorption isotherms showed convex curves, typical of type III isotherms. However, at temperatures above 60 °C, the curves tended to present shapes typical of type II isotherms, with sigmoidal sorption behavior. In both situations, the equilibrium moisture content (0.0236-0.7648 g of water per·g of dry matter) increased with increasing the relative humidity (0.0520-0.9848) and/or decreasing temperature. When analyzing the thermodynamic properties, the net isosteric heat of adsorption (140.88 to 3303.56 J·mol-1), differential enthalpy (-140.88 to -3303.56 J·mol-1), and differential entropy (0.01 to 7.59 J·mol-1·K-1) decreased as the equilibrium moisture increased. The compensation theory was confirmed through the linear relationship between enthalpy and entropy, indicating that the adsorption processes of the BSG were governed by enthalpy. The positive value for Gibbs free energy (199.37 J·mol-1) indicated that the adsorption processes were not spontaneous. From an energetic and stability point of view, a relative humidity of 40% was considered the ideal condition for the storage of BSG. With the obtained information, the drying and storage conditions of wet BSG can be more adequately designed to produce stabilized raw materials for different further applications.(Funder: FAPESP - Grant 2022/05272-8).