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ART25

MAKING A FOOD BLUEPRINT WITH DECAGON

The science of food safety, packaging and useful shelf lives, has come on in leaps and bounds thanks to new techniques that enable complex modelling of water properties…

It is now possible to engineer food products in ways which maximise shelf life, packaging efficiency and product safety.

Water profoundly influences product attributes such as quality and safety. To completely understand water in a product requires an understanding of the amount of water (moisture content) that can be held at a given energy state (water activity). One of the quickest, easiest and most accurate ways to gauge this is to develop a water activity isotherm.

Water activity is the ratio of water pressure in a food (in equilibrium) compared to the saturation vapour pressure at the same temperature. In other words, the amount of water that can be bound into a food at a particular temperature. Pure distilled water has a water activity of one.

Moisture sorption isotherms serve as a blueprint for the ratio of moisture to other constituents. Modern instrumentation (for example Decagon's AquaSorp) has made it possible for anyone to analyse the moisture ratios of a product.

The usefulness of isotherms, water activity graphs, in food engineering depends on being able to achieve high data resolution without drastically increasing isotherm test time.

Despite their value, traditional isotherms have been limited by their low resolution. The high resolution DDI method (Dynamic Dewpoint Isotherm) has opened up new and powerful possibilities. High resolution isotherms can reveal phase transition points - points when products cake and clump or deliquesce (become liquid).

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They can also be very helpful in making shelf life calculations, developing mixing models, modelling temperature abuse, determining the integrity of a protective coating or layer and making accurate packaging calculations.

New methods, such as DDI, make it possible to achieve the necessary resolution while reducing test times to days instead of weeks. These high resolution moisture sorption isotherms make it feasible to model and engineer food products in ways not previously thought possible. The rewards are products that maximise safety, quality, and profitability.

Isotherms can be valuable aids to product design and development. By comparing the isotherms of different formulations, it is possible to determine if a product can be adjusted to allow higher moisture content at a given water activity or a lower water activity at a given moisture content. The result can be a moister product that is still shelf stable.

Likewise, two ingredients at the same moisture content may not be compatible when mixed together. If two materials of differing water activities, but the same moisture content, are mixed together, the water will adjust between the materials until an equilibrium water activity is obtained.

Thus, for a multi-component product, to prevent moisture migration, there is a need to match the water activity of the two components. A great example of this type of product is a snack cake with a crème filling, cake and icing covering. The crème filling, cake, and icing have very different moisture contents, and hence very different textures, but the same water activity. This provides a product with variety but one that is still stable, because the water activities are in the safe range. In addition, the icing coating serves as a moisture barrier to the more moisture sensitive cake interior.

Sorption isotherms are valuable for shelf life prediction. They can be used to determine a food’s monolayer (a culture in a layer one cell thick) moisture content and the corresponding water activity, which represents its most stable state.

This value used to be determined by modelling isotherm data using the GAB or BET equations. A new empirical model called the Double Log Polynomial (DLP) or Chi plot has proved to be even better than the GAB at characterising complex isotherms.

An increase in water activity of 0.1 above the monolayer value will result in a decrease of shelf life by two to three times.

A product's isotherm can be used to determine packaging requirements: taking into account the products sensitivity to moisture and the type of conditions it may be exposed to.

It is possible to work out the time a packaged sample will take to reach a critical water activity when exposed to abuse conditions. The critical water activity would represent a loss in stability and this time would be equivalent to the shelf life of the product.

The isotherm will also show whether a water activity is different if the product is drying than if it is getting wetter. The practical impact is that a moisture content that is safe when drying a sample because it corresponds to a safe water activity (0.6 aw or below) may not be safe when it is getting wetter, because it corresponds to a higher water activity level.

For more information (local distributor details).

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