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White Paper

Characterizing Moisture Relations in Pet Food Formulations
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Decagon Devices, Inc.

Introduction
Managing water is critical to ensuring the safety and stability of pet food. Traditionally, formulators have tried to control the moisture content (total amount of water) in the recipe, but while moisture content provides valuable information about pet food quality, it is only one part of a complete moisture analysis. Water activity is another important moisture measurement that provides essential information about the energy or availability of water in a pet food. Understanding the relationship between these two important moisture measurements is the key to formulating pet food with optimal safety and quality attributes.

Moisture Content
Moisture content is the total amount of water in a product and is determined using many different techniques such as Karl Fischer, loss on drying, microwave, and NIR. It is a common measurement in most labs and provides information about nutritional labeling, concentration of solids, product texture, and product weight.

Water Activity
Water activity measures the energy status of the water in a product. It is equal to the relative humidity of the air in equilibrium with a sample in a sealed chamber. It ranges from 0 for a perfectly dry sample to 1 for pure water. Water activity measurements provide valuable information about pet food safety and quality because they indicate susceptibility to microbial spoilage, chemical degradation, texture changes, and inhibited flow properties.

Moisture Sorption Isotherms
The relationship between moisture content and water activity is complex. An increase in moisture content is usually accompanied by an increase in water activity but the correspondence is not linear. This relationship between water activity and moisture content at a given temperature is called the moisture sorption isotherm (Figure 1). The nature of this relationship depends on the interaction between water and other ingredients and provides valuable insights into product characteristics. The amount of water vapor that can be absorbed by a product depends on its chemical composition, physical-chemical state, and physical structure. The isotherm shape is unique to each product type due to differences in capillary, surface, and colligative effects. For most foods, the isotherm is sigmoidal in shape, although foods that contain large amounts of sugar or small soluble molecules have a J-type isotherm curve.

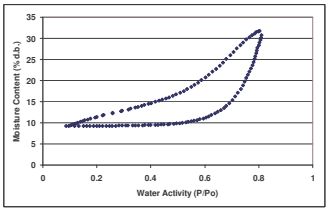

Figure 1. Typical moisture sorption isotherm for dry dog food at 25° C.

Measuring Sorption Isotherms
Constructing a moisture sorption isotherm involves collecting a range of water activities and corresponding moisture contents for a particular sample. One of three isotherm methods is typically used. For most sample types, the three methods provide similar results (Figure 2). However, for samples that experience a phase change during sorption measurement or have slow diffusion properties, the results may vary.

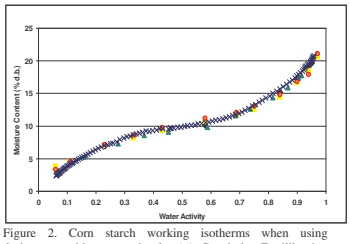

Figure 2. Corn starch working isotherms when using desiccators with saturated salts (■), Proximity Equilibration Cell (●), DVS instrument 1 (♦), DVS instrument 2 (▲), and DDI (×) (DDI data from Decagon Devices in-house testing, data for all other methods taken from (Xin Yu, 2007).

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