

The influence of water activity (a_w) in bakery products



Definition of water activity

Water activity is defined as the current volume and availability of “free” water in a sample and should not be directly compared with the water content (g water/ g substance). The water activity is given as the a_w – value and ranges between 0 (absolute dryness) and 1 (condensed humidity). Only this component takes an active part in the exchange with the ambient humidity and can possibly form the ideal medium for microbiological growth on the surface which influences the microbiological stability. The water activity also has an important effect on the chemical reactions in food.

To determine the a_w -value the relative humidity over a sample is measured after reaching the equilibrium humidity (partial water vapour pressure). This relates proportionally to the a_w -value. An accurate and significant a_w -measurement is only possible, if the sample shows a constant temperature during the measurement. The new Novasina water activity instrument, LabMaster- a_w , is a highly accurate water activity instrument with a temperature controlled measuring chamber in the range of 0°C to 50°C.

The robust LabMaster- a_w instrument series also allows measurements directly at the production line. The menu navigation is based on Windows and supports intuitive commands. A “multi-user” system enables the allocation of different user rights. Thus it complies with various regulations concerning security and traceability.

The exchangeable and intelligent measuring sensor can be calibrated and it saves all the calibration data's. The accuracy is +/- 0.003 a_w , the repeatability +/- 0.002 a_w . A pre-conditioning chamber for the sample reduces the measurement time. The system has interfaces for PC and printer applications as well as visualisation and analysis tools. Up to 9 additional measuring chambers (LabPartner- a_w) can be modular connected to a LabMaster- a_w over a bus connection.

The influence of water activity in foods

The humidity balance value of a product, which is ascertained through its partial pressure of water vapour on the surface depends on the chemical compound, temperature, water content, storage environment (T/rh), absolute pressure and packing.

“Free” water in products is jointly responsible for the growth of undesirable organisms such as bacteria or fungi, which produce “toxins” or other harmful substances. But also chemical/biochemical reactions (e.g. the Maillard reaction) increasingly take place and possibly change the following factors of a product:

- Microbiological stability (growth)
- Chemical stability
- Content of proteins and vitamins
- Colour, taste and nutritional value
- Stability of the compound and durability
- Storage and packing
- Solubility and texture

The optimisation and stabilisation of the product properties requires a partially narrow upper as well as lower a_w value margin. The a_w – value of a product can be changed by adding of so called “Humectants”. Nowadays the measurement of water activity in the food industry is established in research, development, quality control and production.

Bakery products

The expression bakery products also covers the product categories of long-life bakery products as biscuit, cracker, cake, waffle, gingerbread etc., which are durable without cooling or freezing over a longer period (6 to 12 months) at ambient temperature (18°C – 25°C). In long-life bakery products the water content is heavily reduced.

The main criteria for the quality of a durable product is the hygienic security and the optimal sensory properties.

Both factors as quality and durability of a product are affected by the raw material, quality, formulation and storage conditions. The durability of bakery products of middle and high moisture content is limited by the growth of molds. Some species grow at a water activity around 0.8 a_w , while xerophilous species still can grow down to an a_w -value of 0.6.

Bakery products can be filled with various ingredients as cream, nut, nougat, fruits, jam etc.. These ingredients change different factors of the product, which again change the microbial and sensory properties of the bakery product. Combined food which consists of one or several layers differs in its composition. In such food there is the possibility for moisture to migrate from one component to another. This migration happens from regions of high water activity to regions of lower water activity. The water activity is a physical parameter which indicates the “energy status” of the moisture in a material. Thus it is better qualified for the description of the migration tendency of the moisture in a combined food, than by simply controlling the absolute water content of the components.

Waffles

The most important quality characteristics of waffles for ice cream are the texture (crispness) and the mechanical stability. E.g. for waffles filled with ice cream there is quickly reached a water content where the texture passes from crispy to stringy and then to leathery and finally supple.

Thus water activity is better qualified to determine this water migration between the different layers as opposed to simply determining the water content.

Bakery products and fruits

The use of fruits in bakery and confectionery enjoys great popularity during the last few years. The question how the fruits are used is mainly answered by the type and the manufacturing technology of the bakery product. The possibilities are fresh fruits and processed range of products as jam, jelly, gel etc. which is mainly used for long-life bakery products.

The advantages of the „processed fruit“ compared to the fresh fruit are:

- All-season availability
- Simple storage conditions
- Longtime shelf-life
- Simple handling

The main reason for a shortened shelf-life of fruits is primary caused by the microbial spoilage. Thus the environmental conditions of the microorganisms has been made unfavourable.

The following procedures for the preservation of fruits are:

- Lowering of the water activity (a_w -value) with:
 - dehydration
 - adding sugar (osmotic effect)
 - freezing (transformation from water to ice)
- Temperature - heating
- pH – lowering
- oxygen concentration

Durability of sponge cake

Long-life bakery products such as sponge cake are good examples of food where the water activity is one of the main preservation factor. These bakery products have a durability of approximately 6 months in spite of a water content between 15 to 27%. The filling of these products consists of a variety of different sugars, jams or chocolates.

The main preservation factor is the a_w -value which is set in a range between 0.7 and 0.8 a_w . This may be achieved by the help of different sugars (glucose, saccharose) or polyol (sorbitol). But also to spray the surface of a product with ethanol helps to control the growth of xerophilous molds. These steps, together with a packaging under controlled atmosphere build a hurdle technology which assures the microbial stability.

Example of a sponge cake with chocolate filling:

	Water activity (a_w)	Water content (%)
dough	0.755	23.2
Milk caramel mousse	0.785	15.4

The migration and equilibrium properties of water in combined food is an important point for the shelf life stability of the product. High baking temperatures support the level of the a_w -equilibrium between the different components.

Thus the adjustment of the equilibrium between the different layers or components of the food is not only influenced by the baking process but also by the storage time between production and packaging.

The level of the water migration during the shelf life time of a combined food, hence the adjustment of the relative equilibrium humidity, if high enough, is what leads to rather homogenous a_w -values in the different components. This simplifies the use of the water activity as an indicator for the microbial stability of combined bakery products.

To produce a stable and sensory attractive product there should be performed a monitoring during the production according to the HACCP regulations, whereas the a_w -value measurement describes a part of it.

Do you have any problems about the quality and shelf life of your bakery or combined product?

The water activity measurement may help you to find an answer!

Further information you can find on our web site: www.pedak.nl

We are looking forward to hear from you!

