

Water activity (aw) of dehydrated 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.

The relative humidity is measured after reaching the equilibrium humidity over a sample (partial water vapour pressure)

The relative humidity is measured in % rh and relates to the a_w –value as follows:

$$a_w = ERH/100$$

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 following factors:

- chemical compound
- temperature
- water content
- storage conditions (T / rh)
- absolute pressure
- 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 require 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.

Dehydration of food

The dehydration is the removal of water with heat energy and serves for the following purpose:

- increasing of the shelf life of the product by lowering the water content and water activity (a_w)
- manufacturing of “convenient food”
- reduction of weight what enables a better transport and storage
- necessary step during production

Drying processes such as hot air drying, spray drying, freeze drying, drum drying or vacuum drying lead to physical and textural changes of the product.

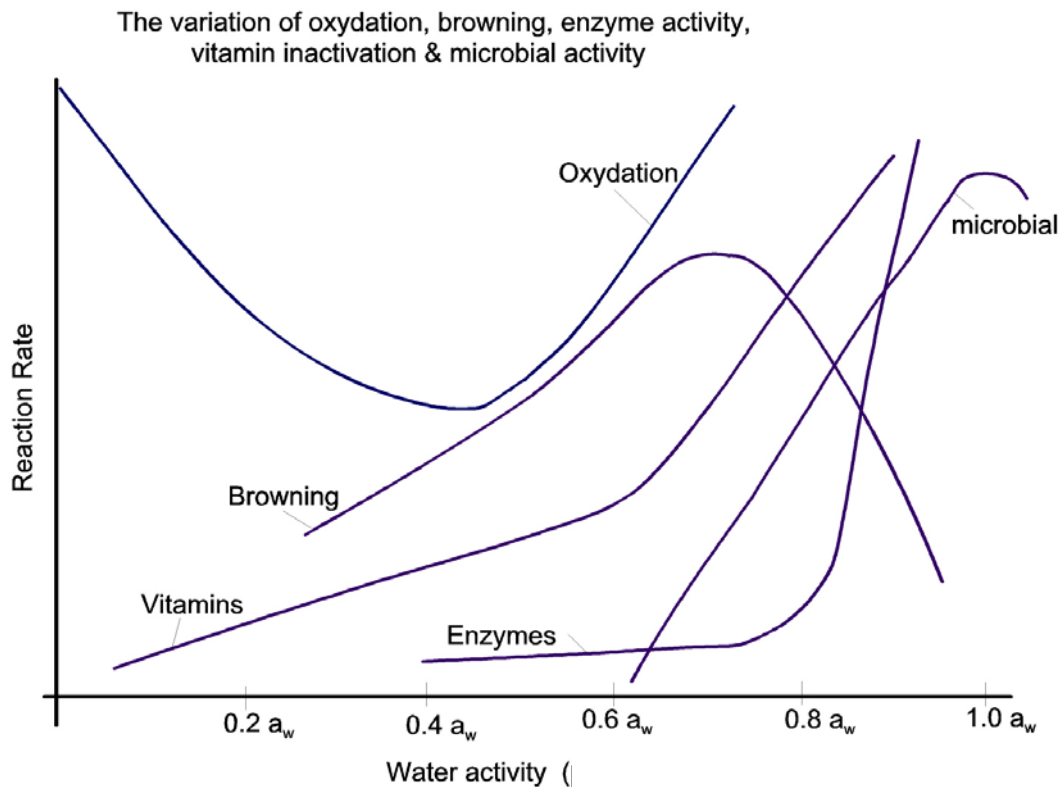
Enzymatic and non-enzymatic influences of the ingredients

During dehydration these influences cause changes of the nutritional value, colour and flavour of the product. A “slow” dehydration will have “more” influence on these changes as opposed to a “fast” dehydration.

Enzymes are not normally inactivated by the drying process, thus enzymatic reactions continue during the reconstitution (adding of water). The most enzymatic reactions are slowed down at an a_w -value lower than 0.8 a_w .

For non-enzymatic reactions primary protein denaturation and the non-enzymatic browning (Maillard reaction) can be named. For different drying processes the non-enzymatic browning causes the most significant changes. The degree of the browning reactions depends on the water content of a product and respectively its water activity.

The probability of the non-enzymatic browning is increased with an increasing a_w -value and reaches its maximum at 0.6 to 0.7 a_w .



Microbial changes during dehydration

These changes play a non-negligible role during a slow dehydration. Like the most enzymes there are also different micro-organisms which survive the dehydration; certainly the survival rate is higher for a smooth drying process (e.g. freeze drying). Therefore no total inactivation of the spoilage organisms can be obtained during dehydration of a product.

Powder and water activity

The knowledge of the water activity of powders as a function of the moisture content and temperature is necessary for the control of the water content during processing, packaging and storage. Thus it is possible to prevent these phenomenon such as caking, clumping or agglutinating of the powder. Caking is the phenomenon where an arid, free flowing powder is transformed to clumps or agglomerates. As a result the functionality is reduced and the quality decreased. This is an omnipresent problem within the food and pharmaceutical industry.

Caking depends on the water activity, time and temperature and is in relationship with the decomposition phenomenon of powders due to gravitation.

To preserve the good free flowing property of a powder and to prevent the caking of a powder the following methods can be applied:

- dehydration on a low water content
- conditioning of the powder at low air humidity and packaging in airtight packing
- storage at low temperature
- agglomeration
- additives and anti-caking-substances

The water activity (a_w) is one of the most important factor to control the stability of dry and dehydrated products during the processing and storage. The control of the water activity in dry and dehydrated products preserves its structure, texture, stability, density and the possibility of reconstitution.

Do you have any problems with the quality of dry and dehydrated products?
The water activity measurement may help you to find an answer!

Further information you can find on our web site : www.novasina.ch .

Novasina AG

Air- and material measurement systems

Neuheimstrasse 12

CH - 8853 Lachen (Switzerland)

Tel. : +41 55 642 67 67

Fax. : +41 55 642 67 70

info@novasina.ch

www.novasina.com

EQUINLAB S.R.L.

Lavalle 1566 5 E, Capital Federal (C1048AAL)

Tel.: (11) 4796-7885 / Fax. : (11) 4796-7885

info@equinlab.com / www.equinlab.com

EQUINLAB
Equipos para la Industria y Laboratorio