The influence of water activity (aw) in meat 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-aw, 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-aw 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-aw) can be modular connected to a LabMaster-aw 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 micro-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

Meat and meat products

The measurement of the water activity in meat and meat products becomes increasingly more important, since the a_w-value influences different chemical reactions in the product as well as the surviving and the resistance of micro-organisms. Hence the water activity is of vital importance for the preserving of foods. Many ways of preserving foods such as salting, preserving in sugar, drying and freeze-drying, reduce the availability of moisture to micro-organisms in the product. All the methods mentioned increase osmotic pressure in food, which means that they lower the water activity.

The reduction in water activity improves the shelf life and safety of meat products, because they are more stable to micro-organisms that can cause spoilage or food poisoning. The various micro-organisms tolerate different minimum water activities. Once the individual a_w limit is reached the micro-organisms can no longer grow respectively are no longer survivable in these surroundings.

The water activity of meat products lies in the upper range of the a_w-scale for foods because of their high moisture content. Fresh meat has the highest water activity (a_w > 0.99). During processing of the meat to meat products the water activity of the product drops, depending largely on the common salt content. E.g. Frankfurter-type sausage, liver sausage and blood sausage generally have a water activity value of 0.97 to 0.96. The water activity of dried meat products, such as dry sausage or raw ham, is correspondingly lower due to higher salt content and has values between 0.92 and 0.80 or less.

Many external and internal factors are responsible for the microbiological stability of meat products. The external factors involved include hygiene during production of the meat, processing hygiene and processing technology.
The internal factors cover parameters as water activity (a_w), degree of acidity (pH), redox potential (Eh), nitrite / nitrate content and competing flora. Within this list of stability factors water activity is one of the parameters which can be measured easily and accurately.

Preservation of meat products

The extension of the shelf life of meat by drying and there the lowering of the moisture content and the water activity is a very old method. There are used different processes, as e.g. the drying with hot air, the drying in vacuum or the most gentle method, the freeze-drying. The moisture content of the final product rests at 3 - 10 %. The shelf life of dried products is limited by the fat oxidation and the Maillard reaction.

Of great significance is the preservation of meat by curing and salting. This method is often used in combination with drying and smoking. In cured pork (bacon, ham), beef, mutton and cured sausage, reduction in the a_w-value by addition of salt is the predominant preserving method. But also nitrite and sometimes nitrate are involved in the cure.
Nitrite plays several roles in the curing of meat. Most obviously, it combines with the myoglobin of fresh muscle and forms a complex which is converted on heating to the desirable heat-resisting "red" nitroso-myoglobin. It also has a inhibitory effect at the pH of cured meat on the growth of some spoilage bacteria.
An important role it plays as well for the inhibition of Clostridium botulinum in canned cured meat.

Smoking is normally used in combination with salting. The moisture content drops depending on the smoking process at 10-40%. A distinction is drawn between hot smoking (e.g. for boiled sausage) and the cold smoking (e.g. for raw sausage or ham). During the smoking the compounds enclosed in the smoke which have a bactericidal and antioxidant effect will penetrate in the meat.

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 meat or meat products? The water activity measurement may help you to find an answer!

Further information about the Novasina water activity meters you can find on our web site: www.novasina.com .

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