Dehydration – what is it and how does it affect meat?

by Karmen Mandic, OctoFrost Group, Volframgatan 3, SE-213 64 Malmö, Sweden.

Dehydration occurs when water loss exceeds water intake. As humans, we breathe and moisture escapes from the breath and from the skin which needs to be balanced by water intake. The process is the same for other organisms with cell structures with high water content.

A piece of meat will start losing weight, dehydrate, after being slaughtered since the moisture moves out from the cell and then evaporates into the air.

The term for dehydration is evaporation or sublimation when water turns from liquid state (evaporation) or fixed state (sublimation) into gas in the air.

Dehydration does not only happen in the freezing process. Injecting moisture with needles does increase the water content, but dehydration will happen in any case.

The freezer environment

In the open air the moisture just escapes, but in a closed freezer the air will start to create snow and ice when the air is saturated with moisture. This is called precipitation. The effect of dehydration in a freezer is shrinkage and damage of the product surface and an actual weight loss of the product that turns out as snow. The snow comes from the product or surface moisture but could have been sold as finished frozen product.

Dehydrating factors

The colder the air, the drier the air will be and hence more dehydration since there is a correlation of dew point and temperature. Quick freezing time will allow for a lower dehydration since more moisture loss happens before the surface of the product is crust frozen. The air dew point is the power of the dehydration process. The drier the air, the quicker the dehydration happens.

A smaller product, with more surface compared to the volume and weight, will naturally dehydrate more than a larger product. Juice or water on the product surface have a higher tendency to evaporate. A product with more moisture content will dehydrate more than a dry product, like any air movement that also will speed up the dehydration.

How to minimise dehydration

Dehydration is limited if precipitation (snow formation) can be avoided. The key to this is keeping the air saturated so air cannot take up moisture from the products. Even if the air is saturated the force of dehydration by any means needs to be avoided.

Low infeed temperature and an efficient crust freezing is a good start. The challenge is optimising settings of airflow and speed, as too much might remove moisture and too low will slow down the freezing time.

Having an even airflow with good aerodynamics reduces turbulence and as an effect lowers the precipitation (snow formation). Air should be kept moving because as soon as it stops the air will start precipitate (create snow).

When the air moves through a coil it gets colder and therefore has a tendency to precipitate. This can be avoided by accelerating the air speed after the coil.

Economic impact

A product with freezer burns will decrease the quality and value of the product. With light surface moisture, the product can be protected but the loss in weight is still applicable.

Table 1. Typical factors affecting dehydration.

- Infeed temperature
- Temperature of air
- Freezing time
- Saturation
- Relation of surface and volume
- Surface water
- Water content
- Air speed

Traditional IQF tunnel freezers have 1.5-2.0% dehydration which can be measured as snow formation, but in optimal conditions can be reduced to 0.3-0.5%.

In a spiral freezer the dehydration can be up to 4% of product loss in weight. Sometimes this can be seen on products as ice crystals which gives a less favourable appearance.

A cold storage freezer will not handle a wet product so the comparison cannot be made directly. A cold storage freezing and spiral freezing are both so slow that ice crystals will be large and the cell structure will be damaged. In these cases the drip loss after a defrosted product is of even more importance to quality.

The dehydration as snow formation requires the exact same energy to create the product and to freeze it so the loss is on the final product. As an example, with a yearly production value of €5,000,000 there is a saving of €50,000 per year if dehydration is decreased by 1%.

Conclusion

There are many factors in the food production process influencing the dehydration level of the products. By understanding factors impacting the dehydration levels that might occur in the last part, the freezing process, output of products can be increased – all without spending any money on raw material, manpower or power consumption. ■