

Water Activity Parameters and Coffee

Roast Coffee

Consumers prefer fresh coffee. The perception of freshness is the result of the age of the coffee and the storage conditions it is subject to. The processes that cause staling are the result of the evolution of volatile fresh roasted flavors as the result of different chemical reactions. The rates of these processes are thermodynamically determined. As a descriptor of thermodynamic availability of water within the mass of roasted coffee, water activity is an important consideration in determining the potential shelf life of coffee.

Consumer perception of freshness has been shown to be partially related to the concentration of methanethiol, a mercaptan. As this chemical reduces, furfuryl mercaptan increases. It is perceived as “fresh roast coffee” in concentrations of 0.1-1, but as overly sulfury, unpleasant, and stale when perceived at concentrations of 5 to 10 ppb. Other chemicals it increases as the result of a Maillard reaction, a non-enzymatic browning process. This activity has been shown to increase at higher water activity levels.

Aldehydes and ketones are present in relatively high levels in freshly roasted coffee and these are readily lost by means of oxidation and volatilization during storage. Heightened water activity can accelerate these processes.

Another important reaction resulting in coffee that is perceived as stale is lipid oxidation. These reactions are especially accelerated at water activities of 0.45 and above.

The water activity in roast coffee is the result of the initial moisture content of the green bean, the degree of roast, degree of quenching, fineness of grind, and ambient conditions of storage, including humidity, temperature, and pressure (barometric pressure in the case of open storage). Ranges reported by Labuza in his 1994 study entitled Kinetics of the Shelf Life of Roasted and

Ground Coffee as a Function of Oxygen, Water Vapor Pressure, and Temperature reported ranges of 0.33 to 0.67 for commercial roast and ground coffee.

For better quality medium-roast coffee that is not quenched, Coffee Analysts are reporting a water activity range of 0.18 to 0.30. The higher values came from product packaged in polyethylene bags, while the lower values came from product packaged in foil laminated bags. Initial data analysis indicates that higher water activity (above 0.25) result in noticeable flavor loss and a tendency towards stale flavor over a period of two weeks in the case of whole bean coffee.

Currently, a study is being conducted by Dr. Ted Labuza of the University of Minnesota on the quantification of these phenomena taking into account initial conditions of the product and conditions of storage.

Roasted coffee is highly absorptive of water and increase of water activity can occur with greater increase of water taken on. This will, in turn, lead to the quicker staling and a shorter shelf life. Improper conditions of storage, including environmental factors and packaging material, can be hypothesized if water activity increases at too great a rate.

Green Coffee

The moisture content in green coffee has long been used as an indicator of coffee quality, age, and tendency to pick up off flavors. The flavor faults known as “ferment” and “moldy” are the results of microbial or fungal action. This is known to increase at high water activity levels, such as 0.7 for molds and 0.8 for bacteria.

Green coffee deteriorates very gradually, but the “past crop” taste, described in literature as “papery,” woody,” or “rubbery,” is partially associated with the hydrolysis of sucrose into

glucose, especially. Higher water activity can possibly provide an indication of the level of this activity.

When roasting coffee, the free water at the surface of the bean (which would be reflected by a higher water activity) must be evaporated away by heat before the heat-produced chemical processes known as roasting actually begin. This is known as the “drying stage” of the roast. Measurement of water activity in the green bean can assist in estimating the amount of time and heat that will need to be applied to initiate the actual roast. This is especially important to know in dealing with blends. Individual blend components usually have variable drying stages that can be measured more exactly through water activity than by total moisture.

During harvest, the production of ochratoxin is of great concern from some origins. It is stated in Modeling and HACCP Tools for Coffee Quality Improvement (J.M. Frank, Association Scientifique Intemacional du Cafe, 18e Colloque, Helsinki, Finland, 1999) that (subject to verification) “All coffee, cherry or parchment, must spend no more than four days between $A_w = 0.95$ ($\approx 27\%$ moisture content) and $A_w = 0.80$ ” can be used as a drying specification to prevent contamination. This is confirmed in experiments done by M. H. Tanawaki et al and reported at the same colloquium.

In summary, the measurement of water activity can provide valuable information about coffee in its green, roasted, and packaged form. The challenge that remains is to develop definitive measurement standards and parameters.