

Two new methods for measuring almond moisture content

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Almond quality and processability is highly dependent on almond moisture content. Too wet and the almonds can lose quality and too dry the almonds are easily chipped and scratched during processing. Currently, the determination of kernel moisture content requires a sample of almonds to be collected, shelled and about 100 kernels placed into a moisture test machine. This process is time consuming to crack out the sample and gain a reading.

Two new methods are being developed that can measure an almond's kernel moisture content even without taking the kernels out of their hulls or shells.



Top: John Fielke with 2 metre moisture spear ready to insert into stockpile of almonds.

Bottom: 1 metre moisture spear inserted into a bin of kernel.

Equilibrium humidity method

Almonds over time will reach equilibrium with the air around them. For example, a Nonpareil almond (kernel, inshell or inshell) at 20°C with a 6 percent kernel moisture content will not gain or lose moisture when the air around them is at 65 percent relative humidity. At a lower humidity the kernel will lose moisture and at a higher humidity the kernel will gain moisture. This moisture moves through both the shell and hull.

Each variety of almond has a unique relationship of its kernel moisture content



Methods for measuring almond kernel moisture content

with its temperature and surrounding air humidity. So long as almonds are no longer wetting up or drying this relationship for kernels is the same for loose kernels and kernels still in their shell and/or hull.

Hence, kernel moisture content can be determined by inserting a temperature and humidity sensor into (1) a stockpile of in-hull almonds, (2) a bag of inshell almonds or (3) a bin of shelled kernel and measuring the temperature and relative humidity of the air in the voids between the almonds. If the bulk almonds have been in place for many days a stable reading of moisture content can be gained within minutes. However, if the sample is not yet at equilibrium it can take several days for the sample to equilibrate and provide an exact measure of kernel moisture content.

The company Ag-IQ Australia has developed a stainless steel spear with one and two metre length options. The one metre spear suits in-factory tests of processed almonds whilst the two metre spear is better for insertion into stockpiles of almonds. The moisture spears have a covered digital temperature and humidity sensor on one end and insertion handles and a digital display on the other. The display has the ability to select the almond variety and give a reading of kernel moisture content equivalent to the air conditions surrounding the almond. The unit currently uses previously published calibrations for Nonpareil and Monterey almonds from work at UC Davis in California. In the coming months, additional varieties will be added to cover the most common almond varieties ready for 2019 harvest. The unit is calibrated against oven drying of kernels and the unit

will have the ability to tweak the calibration to match any calibration standard.

The digital sensors do not need recalibration and will provide an accuracy of measurement of $\pm 0.2\%$ kernel moisture content when the air near the almond is in equilibrium with the kernel. It also has a very high level of repeatability of $< 0.1\%$ moisture content for measurement of the same sample.

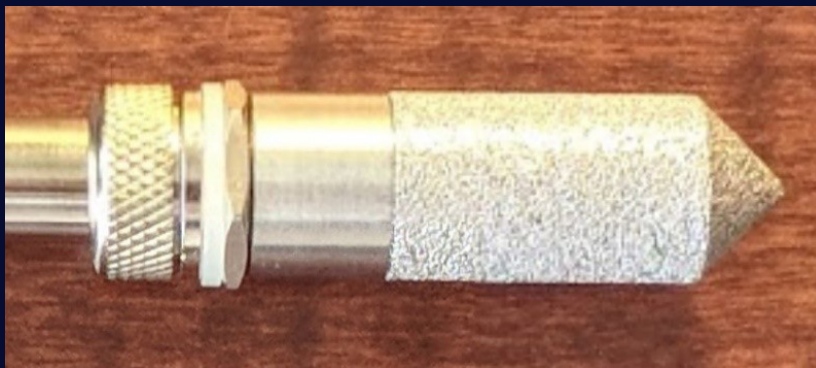
The advantage of the equilibrium humidity method is that the sample being tested can be a mix of any proportion of loose kernel, inshell or in-hull almonds. The unit can be supplied with a digital display and can have the option for the sensors to be connected wirelessly via the internet to give remote access to moisture readings at any time from anywhere. This remote access is particularly valuable for monitoring and control of the dehydration of almonds or monitoring changes during long term storage. The current retail price of the moisture spear is \$1,350 and \$1,400 (excluding GST) for one and two metre spears, respectively.

Microwave method

Most people are familiar with using a microwave oven to heat food. It is the water in the food absorbing the microwaves that does the heating. In a similar way, if a microwave is passed through a layer of almonds the amount of absorption of the microwave signal can be calibrated to give a measure of the total amount of water in the sample. Whereas the power of a home microwave oven is generally above 800 Watts, the



Microwave antenna with sample of in-hull almonds to measure kernel moisture content



Close up of porous filter that protects the temperature and humidity sensor



Typical display showing variety and kernel moisture content

power of the microwave signal for moisture measurement is only 0.03 Watt. Hence, this low powered microwave will not heat the almonds nor be a safety risk to users.

The big advantage of microwave moisture measurement is that it is a transmission process that looks through the almonds and measures the total amount of water in the sample. Hence, even if the almond is still drying or has just been wet by rain, the measure will give an indication of the final moisture if it were to reach equilibrium.

The sample of almonds for microwave moisture measurement must be all of the same form of either all in-hull, all in-shell or all kernel and there is an individual calibration for each of these forms. To use the microwave moisture measurement method, the sample must be placed in a uniform thickness between a transmitting and receiving antenna. The current version of the technology uses a sample thickness of 100 mm. Work is planned to be undertaken at the University of South Australia to increase this thickness to at least one metre so that moisture of a whole bin or large bulker bag can be tested without the need for taking a sample or inserting antennas into a sample.

A microwave moisture meter could have the transmitting and receiving antennas fitted on each side of almonds being conveyed during processing or they could be fitted into the hopper of an almond pickup and/or runner. This method can give an instantaneous reading of almond moisture content which could provide both whole fruit moisture content or equivalent kernel moisture content.

The microwave moisture measurement method should be ready for testing in the 2019 almond harvest. Using currently available components the estimated retail price of a microwave moisture meter is \$6,000 (excluding GST) plus installation requirements.

Note: Ag-IQ Australia is a private company owned by John Fielke. This activity is being undertaken as a private activity and the University of South Australia is not involved in this activity in any way.

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Winter/ Spring 2018

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