Moisture management and mould prevention during coffee drying limits the risk of quality claims

High quality Arabica coffee can attract premiums on the world market as well as locally in Vietnam. However, clients require coffee without physical and sensorial defects and with a good physical appearance. One principal factor that determines bean quality is the development of moisture content in the coffee bean during drying.

Why is coffee drying necessary?
After wet processing, parchment coffee needs to be dried quickly to prevent the development of microbiological activities (moulds, yeasts, etc.) which can result in severe cup defects as well as create toxins which can pose health risks to consumers. Due to the weather conditions in Vietnam, most coffee drying is done mechanically, only a small amount of sun-drying is possible. Coffee must be dried so that it has a moisture content of at least 11-12%. At this level, coffee beans will preserve their inherent quality, mould development is limited and minimal breakage will occur during hulling, grading and exporting.

However, because Vietnam’s Arabica growing areas are rather low in altitude, beans expand quickly resulting in a more open or “spongy” structure compared to beans growing in altitudes above 1,000 metres. As a result of this open structure, beans are more subject to rewetting. Therefore, a final moisture content after drying of 10 to 11% is recommended for Vietnamese coffee processors, thus ensuring that moisture content on arrival overseas will not exceed 12%.

The drying process
For effective drying, the relative humidity of the drying air must be lower than the equilibrium relative humidity of parchment coffee. When this condition is given, surface moisture of beans will evaporate and the coffee beans dry.

During drying, the moisture trapped inside the bean slowly migrates to the outside and is absorbed by the warm air. Thus, a chain reaction takes place - moisture evaporates from the surface of beans causing moisture from the inside of the bean to travel to the surface.

Drying air must also move past the beans quickly enough to carry away the excess moisture and maintain this differential. When it remains static, drying air will be saturated which means no further drying can take place.

Uniform drying will be achieved, if temperature and relative humidity of the air are correct and coffee is regularly turned.
The concept of relative Humidity and Equilibrium Relative Humidity

Relative Humidity (RH) is a percentage expression comparing the amount of moisture the air holds compared with the maximum amount it could hold for a given temperature.

Equilibrium Relative Humidity (ERH) determines at what given temperature the relative humidity of the ambient air is in balance with the coffee seed moisture content. At an Equilibrium Relative Humidity, no exchange of humidity from the ambient air to the seed and vice versa is taking place - the seed neither takes up nor loses moisture.

As it can be seen from the graph for equilibrium relative humidity (Fig. 1), moisture content of wet parchment coffee declines steeply with only a small reduction of RH of the ambient air. It is worth mentioning, that parchment coffee can be dried to below 20% moisture content with a relative humidity of drying air of up to 80% which underlines the potentials of recycling drying air, especially for pre-drying.

As moving closer to the target moisture content of 11 to 12%, the graph flattens, showing that it needs a stronger decrease of RH in the drying air to reduce moisture in the coffee parchment.

Sun Drying

Whenever climate conditions allow, sun drying is the preferred drying technique. It is cheap and in addition, the ultraviolet light of the sun is considered to bleach out chlorophyll from the beans, reducing green and grassy flavour components. Sun drying needs to be supervised very carefully as site and climate conditions strongly influence coffee quality.

Drying patios should be made out of concrete, physically clean, free of cracks and away from coffee pulp and/or processing effluents to avoid microbial contamination. It also must be avoided to dry coffee on the bare soil as the soil is a rich source of microbiological infection. If a concrete floor is not at hand, coffee should be dried on plastic canvas, on elevated tables or locally made, ventilated tunnel driers.

The risk of rewetting of coffee is high when drying outside and is one of the main causes of mould development. In order to avoid rewetting, the manager needs to react quickly and cover the coffee on the drying yard before rain gets in contact with coffee. As soon as weather conditions are dry again, the cover must be removed again to allow ventilation and further drying. If coffee is left too long covered while the sun is shining, beans will start to “sweat” and both mould infection and cup defects will develop quickly.

During night, coffee must be covered by a canvas to

*** REMEMBER ***

"It is impossible to dry with no air movement."

"The air is the conduit, the differences between the RH and ERH is the driving force"

"Drying rate gets slower as it proceeds"
prevent rewetting from condensation due to cooler ambient temperatures.

**Machine Drying**

Effective management of temperature and moisture are critical when machine drying. Neither drying too quickly at excessive temperatures nor drying too slowly with a low temperature will bring good results. The ideal temperature for drying is between 45 and 55 degrees Celsius. An increase of only 1 degree Celsius of air temperature lowers the relative humidity of the air by approx. 5%! This shows how much care must be taken in temperature control.

When the air for drying exceeds 55 degrees Celsius for prolonged periods, the air is withdrawing moisture from the beans too quickly and unevenly. Parts will be dry while others remain wet. Very often at excessive temperatures, the outside of beans is dried rapidly and a hard shell on the outside develops which prevents air penetrating the bean and hinders further drying. The result is that beans will be over-dried or crystallised on the outside while remaining moist in the inside. These beans will crack easily during hulling and sorting. Even if the moisture meter displays a moisture content of around 11%, the real moisture content within these beans will not be detected: the high moisture content inside the bean is protected by a solidly dried cover making reliable measurements impossible.

This uneven distribution of moisture as a result from drying with excessive temperatures will also cause quality problems over time: during storage and shipment, moisture from the inside of the bean will migrate and spread evenly rewetting the bean (so called “moisture rebound”). The elevated moisture content will speed up the process of ageing and increases the risk of mould infection and must be avoided.

**Foreign smells**

Sources of foreign smells (smoke from burners, burnt rubber, oil/petrol) must not get in contact with the drying air nor with wet parchment, as wet parchment takes up foreign smells quickly and will destroy inherent taste characteristics. For mechanical driers, heat exchangers must be used not allowing smoke from burners to get in contact with the coffee.

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**At a GLANCE**

**PHYSICAL CHARACTERISTICS OF BEANS DURING DRYING**

- **50-45% moisture content**
  - Skin dry, i.e. no water between the bean and parchment

- **45-30% moisture content**
  - White Stage, i.e. bean whitish all over

- **30-22% moisture content**
  - Soft black stage, i.e. beans soft, translucent, elastic and dark colour
  - Medium black stage, i.e. beans fairly hard with dark colour

- **15-12% moisture content:**
  - Hard black stage, beans hard and black

- **12-10% moisture content**
  - Fully dry bean, i.e. no sign of blackness, typical green colour
Control measures
Thermometers are crucial to monitor the temperature of the air in coffee driers. In large area flatbed driers, the distribution of temperature can be very uneven so that more than one thermometer might be needed. In rotary driers, the mass of air is generally smaller and therefore the control of drying temperature is easier.

Regularly calibrated moisture meters must be used to continuously check moisture content during drying. Before taking a measurement, it is important to allow the coffee to cool down before filling it in the auger. If coffee beans have not been cooled down sufficiently, the measured moisture content will be displayed incorrectly.

Identifying drying defects
The experience of the quality manager is crucial in judging the quality of different batches also by physical characteristics.

Coffee beans which have been dried at excessive temperatures can be visually identified as greyish and weak in structure (“crystallised” beans). Beans affected by uneven, too hot drying will easily crack when bitten with the teeth and consist of a chewy interior. Internal moisture migration will take place leading to a marbling effect and a pale colour of the beans. These beans are also subject a higher risk of mould development. Prolonged drying times will bleach out the typical green colour from the beans making the bean look yellowish and slightly transparent whilst being very hard.

The “tooth test”
Remove the parchment to expose the green bean. Find a place in the front corner of the mouth where the bean sits nicely in between the teeth, and bite as hard as possible.

1. Bean crushes → too moist
2. Bean remains with a teeth mark → almost dry
3. Bean breaks/fractures → too dry
4. Bean does not leave a teeth mark → finish dried, ready for storage