Water calorimetric properties and cytoplasmatic glasses associated with desiccation tolerance in *Coffea arabica* L. and *Coffea canephora* Pierre seeds

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Introduction

The propagation of coffee trees is primarily accomplished with seeds that have slow and non-uniform germination (*Figure 1)* and poor storage potential, which makes it difficult to obtain high quality coffee seedlings of the desired quality at the proper time for planting.

The physiological causes of this poor performance may include the presence of an inhibiting endocarp, low water and O_2 uptake, the presence of natural inhibitors, differences in hormonal balance (Silva et al., 2004) and sensitivity to desiccation. Desiccation tolerance of coffee seeds depends upon characteristics inherent to the species, the developmental stage (Guimaraes et al., 2002; Estanislau, 2001), and the rate of water removal from the seeds (Rosa et al., 2005; Dussert et al., 2006). Coffee seeds achieve their highest physiological performance from greenish-yellow to cherry maturation stages (*Figure 2*).

Studies of desiccation tolerance are enhanced by examining the state of water and cell cytoplasm components in seeds using Differential Scanning Calorimetry (DSC). The glass transition temperature and freezable/unfreezable water determination can enhance our understanding of the causes of sensitivity or tolerance to coffee seed desiccation (Eira et al., 2006).

Therefore, the objectives of this study were to determine the factors that contribute to desiccation tolerance and longevity of cherry and greenish-yellow coffee seeds exposed to different drying rates and final moisture contents.

Figure 1 – Illustration of slow germination of coffee seeds.

Figure 2 – Coffee seedlings produced from greenish-yellow (A) and cherry seeds (B).

Materials and Methods

Coffea arabica L. and *Coffea canephora* Pierre seeds were collected at the cherry and greenish-yellow fruit stages. The experimental design was a completely randomized 2x2x4 factorial scheme consisting of two maturation stages, four seed moisture contents, 0.40, 0.30, 0.20 and 0.12g.g^{-1} (w/w), and two drying rates, fast in a small-scale stationary dryer (25 m^{3}min^{-1}ton^{-1} air flow and 25ºC), and slow in the shade (at a mean air condition of 25ºC and 60% of humidity relative). Immediately after drying, the seeds were sealed in polyethylene bags and stored at 10ºC. At succeeding two month intervals during one year of storage, the seeds were submitted to physiological quality assessments, electrophoretic analyses of iso-enzymes and DSC.

DSC thermograms were analyzed to the heat capacity, melting endotherms such as freezable and unfreezable water. Samples weighing about 10 mg were equilibrated at -50ºC, held isothermally for 2 minutes, heated at the rate of 5ºC.min^{-1} up to 60ºC.

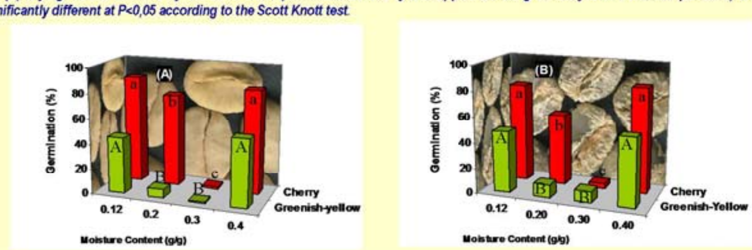
Preliminary results

After one year of storage, the drying rates did not have a significant effect on the physiological quality of coffee seeds. Seeds harvested in the cherry stage had greater storage potential compared to those in the greenish-yellow stage (*Figures 3 and 4*).

The greatest reductions in physiological quality occurred when the coffee seeds were stored at 0.30 g.g^{-1} (w/w) of moisture content at both maturation stages. It is known that at intermediate humidity (between -15 and -5 MPa) respiration and damage mediated by free-radicals can occur, but repair processes cannot and, if seeds are stored wet or are dried slowly, they will deteriorate (Walters et al., 2001), similar to mechanisms related to "accelerated ageing".

Figure 3 – Effect of maturation stages and moisture contents on radicle protrusion of coffee seeds stored for one year, after slow (A) and fast (B) drying. Means followed by the same letter (lowercase for cherry and uppercase for greenish-yellow seeds comparisons) are not significantly different at P<0,05 according to the Scott Knott test.

Figure 4 – Effect of maturation stages and seed moisture content on germination of coffee seeds stored for one year, after slow (A) and fast (B) drying. Means followed by the same letter (lowercase for cherry and uppercase for greenish-yellow fruits comparisons) are not significantly different at P<0,05 according to the Scott Knott test.



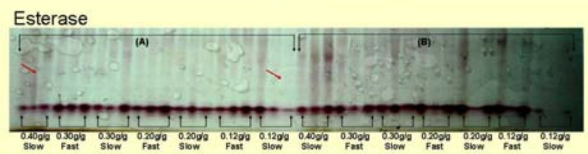
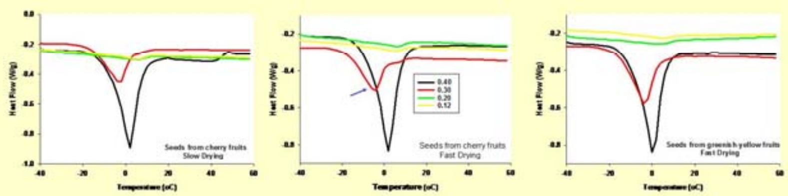


Figure 5 – Esterase iso-enzyme activity in cherry (A) and greenish-yellow (B) coffee seeds exposed to slow and fast drying at four moisture contents, during storage.

The esterase iso-enzyme gel profile (Figure 5) showed the lower enzyme activity for wet and dry coffee seeds, which coincided with highest physiological quality. The more deteriorated seeds resulted in higher esterase activity.



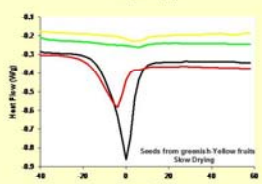


Figure 6 – DCS thermographs of cherry and greenish-yellow coffee seeds exposed to slow and fast drying at four moisture contents.

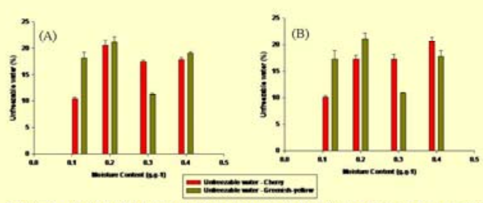


Figure 7 – Unfreezable water in cherry and greenish-yellow coffee seeds exposed to fast (A) and slow (B) drying at four moisture contents.

The thermographs of coffee seeds (Figure 6) show similar results except for cherry seeds dried fast at 0.30g.g^{-1}, which had the lowest physiological quality after one year storage. In these seeds, the major transition around 0ºC, attributed largely to ice melting, occurred at lower temperature than other treatments, mainly for cherry seeds dried fast.

Preliminary comparisons between freezable and unfreezable water amounts and physiological quality assessments do not account for the poor storage capacity of coffee seeds.

In order to detect glass transitions, a second-order transition characterized by changes in heat flow capacity or a inflection point, fresh seeds are currently being dried to lower moisture contents than 0.12g.g^{-1}. and will be analyzed.

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