

EQUILIBRIUM MOISTURE CONTENT AND WITHERING

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The equilibrium moisture contents of six clones of varying quality potential were determined at 21°C at different relative humidities.

The desorption isotherm pattern for the clones were found to be S-shaped as observed with made tea. The values of equilibrium moisture obtained for each clone were used to evaluate the constants of the linear form of Henderson's equation.

It was found that it is mainly the surface moisture which is removed during withering and the rate is independent of the clone. The relative humidity of the air used for withering in Sri Lanka tea factories lies in the region of economical return.

INTRODUCTION

Withering is a process largely of removal of moisture from green leaf. This is achieved in factories in Sri Lanka by passing a stream of air over the leaf. Relative humidity (r.h.) of the air is an important factor, which governs the rate of moisture removal from the leaf. In this study, the equilibrium moistures that will be reached, if air of constant relative humidity is passed, has been investigated, in order to determine the economical range of relative humidities that could be employed for withering.

Several equations have been derived by many workers to describe moisture sorption isotherms. Equilibrium moisture values obtained with green leaf have been applied to the moisture sorption equation obtained by Henderson (1952) as in the case of black tea (Jayaratnam & Kirtisinghe, 1974).

EXPERIMENTAL

Desorption measurements were made from six clones DT 1, TRI 777, TRI 2024, TRI 2025, TRI 2026 and TRI 2043 which are of varying quality potentials (Kirtisinghe *et al* 1968) grown at St. Coombs, at various humidities and at 21°C. Samples for measurement were made exclusively from 2 leaf + bud of each clone. Saturated salt solutions whose equilibrium relative humidities were determined by reference to the International Critical Tables (Spencer, 1926) were placed in desiccators which were then used as constant humidity chambers, with their lids tightly closed before use. The moisture contents of the samples were determined by the moisture oven technique (Ceylon Standard 28). Samples were assumed to have reached equilibrium with its surroundings when there was no gain or loss in weight between the moisture readings taken on two successive occasions, taken at least 5 days apart. The drying curve of each clone too was determined. They were obtained by drying samples from each clone at 55°C in a thermostatically controlled oven and determining the moisture content at regular intervals by the moisture oven technique.

RESULTS AND DISCUSSION

The desorption characteristics of clone TRI 777 is given in Fig. 1. The desorption patterns obtained for clones DT1, TRI 2024, TRI 2025, TRI 2026 and TRI 2043 are similar to Fig. 1. Each point plotted on these curves is the arithmetic

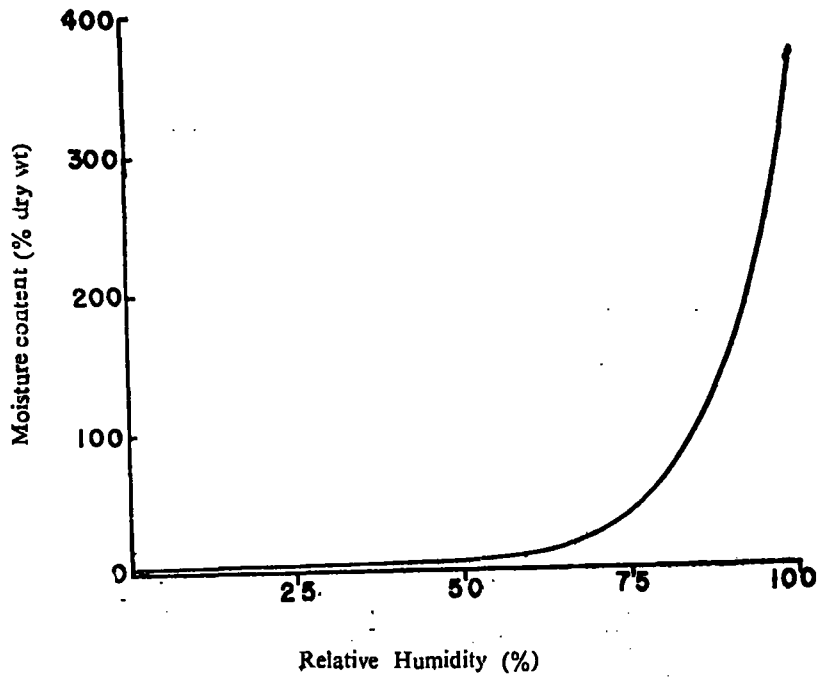


Fig. 1 - Moisture desorption Curve of clone TRI 777

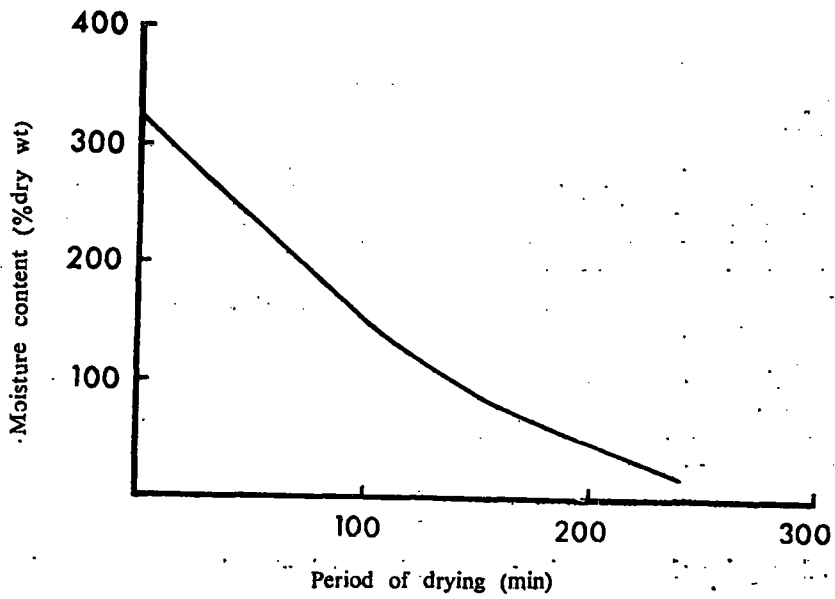


Fig. 2 - Drying curve of clone TRI 777

mean of readings of moisture content of duplicate samples after the samples attained equilibrium conditions with their surroundings. From the desorption curve it is seen that the difference in equilibrium moisture levels at r.h. less than 70% is very low. The benefit one could, therefore, achieve by employing air of r.h. less than 70% is minimal. This confirms the general practice adopted in Sri Lanka factories where one employs for withering, air of r.h. around 70% obtained by conditioning air to 24.0 — 29.5° C (75° — 85°F) with a hygrometric difference of 3.5 to 4.5°C (6—8°F).

Henderson (1952) developed the following equation for describing sorption phenomena.

$$(1-rh) = e^{-KM^n} \dots\dots\dots (1)$$

where rh = relative humidity
 K = factor, varying with material
 M = equilibrium moisture content, dry basis
and n = exponent varying with material

This equation could be transformed to the linear form

$$\log \log \left[\frac{1}{1-rh} \right] = n \log M + k^1 \dots\dots\dots (2)$$

where $k^1 = \log_{10} \left[\frac{k}{2.303} \right]$

The values of n and k^1 for the clones investigated are given in Table 1.

TABLE 1 — Values of the constants in the linear form of Henderson's equation for desorption data of clones DT 1, TRI 777, TRI 2024, TRI 2025, TRI 2026 and TRI 2043.

| Clone | n | k^1 | Correlation coefficient |
|----------|------|--------|-------------------------|
| DT 1 | 2.55 | — 3.30 | + 0.97* |
| TRI 777 | 2.76 | — 3.49 | + 0.96* |
| TRI 2024 | 2.90 | — 3.78 | + 0.99* |
| TRI 2025 | 2.70 | — 3.62 | + 0.99* |
| TRI 2026 | 3.03 | — 4.15 | + 0.99* |
| TRI 2043 | 2.77 | — 3.79 | + 0.99* |

*Significant at $P < 0.001$

Further analysis revealed that the regression coefficient obtained for any clone, did not differ significantly ($P < 0.05$). Therefore, grouping all data corresponding to the clones and finding a common regression coefficient the following equation is obtained.

$$\log \log \left[\frac{1}{1-rh} \right] = 2.78 \log M - 3.68$$

The drying curves of the clone TRI 777 is given in Fig. 2. The drying curves for clones DT 1, TRI 2024, TRI 2025, TRI 2026 and TRI 2043 are similar to Fig. 2. The rate of drying Vs time curve for clone TRI 777 is given in Fig. 3. It consists of a constant rate period and falling rate period. The rate of removal of moisture is constant while the surface moisture is removed, as it does not depend on the amount of moisture present. During the falling rate period bound moisture is removed and the process is diffusion controlled. The moisture content of 55% (wet basis), which corresponds to a wither of approximately 45% (made tea

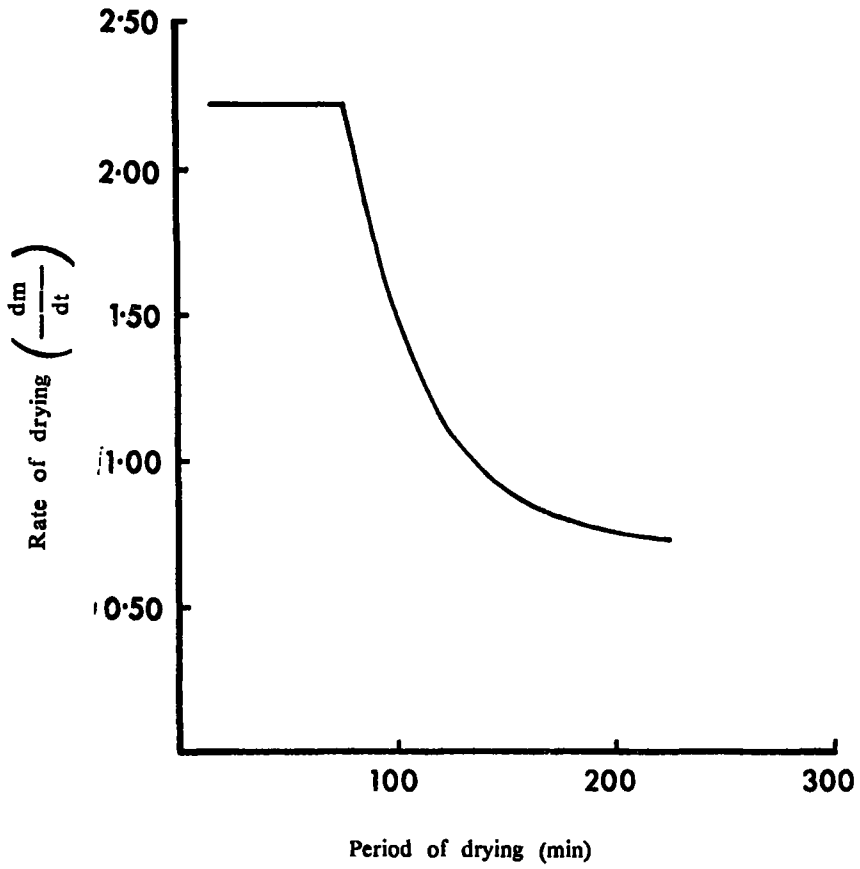


FIG. 3 - Rate of drying Vs time curve of clone TRI 777

to withered leaf) lies close to the end of the constant rate period. The moisture that is removed during withering, therefore, is mainly surface moisture. The surface moisture is independent of the anatomical characteristics etc. of the leaf. Further the desorption curves obtained for the clones too were very much similar. It follows, therefore, that the rate of withering is independent of the nature of the clone.

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