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Research Paper

Effect of Blanching and Temperature on Drying Kinetics of Basil (*Ocimum sanctum*) Leaves in Hot Air Tray Drying"

Parmar M.R. Sardar N.R.*
[1.] *College of Horticulture, Anand Agricultural University Anand.*
[2.] *College of Food Processing Technology and Bioenergy Anand Agricultural University Anand.*

Abstract
*The present study investigates the drying kinetics of basil leaves (*Ocimum sanctum*) using a hot air tray dryer at three drying temperatures: 45 °C, 55 °C, and 65 °C. Both blanched and unblanched samples were evaluated to determine the effect of blanching pre-treatment on drying behavior and moisture removal rate.*
Results showed that the drying rate decreased progressively with drying time across all temperatures and treatments. For unblanched samples, the drying rate reduced from 1.43 to 0.18% d.b./min, 7.29 to 0.80% d.b./min, and 9.51 to 0.36% d.b./min at 45 °C, 55 °C, and 65 °C, respectively. In blanched samples, the drying rate decreased from 6.03 to 0.18% d.b./min, 11.61 to 0.25% d.b./min, and 11.70 to 0.70% d.b./min, respectively. The arithmetic decrement in drying rate was consistently higher in blanched samples, indicating faster initial drying followed by a rapid decline.
These findings confirm that blanching significantly enhances initial moisture diffusivity, especially at moderate temperatures like 55 °C, but also causes a sharper drop in drying rate over time. The results suggest that blanching combined with optimal drying temperature can effectively improve drying efficiency while potentially preserving the physical and chemical quality of basil leaves.

Keywords
- *Basil leaves (*Ocimum sanctum*), Hot air tray drying, Blanching pre-treatment, Drying kinetics*

I. Introduction

Drying is one of the most widely used post-harvest preservation techniques, particularly for medicinal and aromatic plants like basil due to its ability to reduce moisture content, inhibit microbial growth, and prolong shelf life (Mujumdar, 2007). Among various drying methods, hot air tray drying is extensively employed in small- and medium-scale processing industries due to its operational simplicity, controllable parameters, and cost-effectiveness (Ceylan et al., 2007).

The drying kinetics of leafy materials are significantly influenced by drying temperature, air velocity, and sample pre-treatment. In particular, blanching, a thermal pre-treatment involving short exposure to hot water or steam, has been shown to modify the microstructure of plant tissues, inactivate enzymes, and enhance moisture diffusivity (Santos & Silva, 2008). However, blanching can also accelerate moisture loss in the early stages of drying and affect the drying rate pattern (Doymaz, 2012).

Understanding the drying behavior and rate decrement of blanched versus unblanched basil leaves is essential to optimize drying conditions for improved quality and efficiency. Drying rate, a critical parameter, reflects the speed of moisture removal and indicates changes in drying mechanisms over time. Evaluating the arithmetic decrement in drying rate across different temperatures provides insights into the effect of blanching on internal moisture transport and drying dynamics.

In this study, hot air tray drying of blanched and unblanched basil leaves was carried out at 45 °C, 55 °C, and 65 °C. The objective was to assess how blanching influences drying rate patterns and arithmetic decrement under varying thermal conditions, thereby helping to identify optimal drying strategies for preserving the quality and bioactivity of dried basil leaves.

II. Material and Methods

Raw Material Procurement and Preparation

Fresh and healthy basil leaves (*Ocimum sanctum*) were harvested from the experimental plot of the university farm. Leaves of uniform size and maturity were manually selected and washed thoroughly with clean water to remove any adhered dust, soil, or foreign matter. After washing, the leaves were drained and blotted gently using blotting paper to remove surface moisture.

Blanching Pretreatment

The selected basil leaves were divided into two groups: unblanched (control) and blanched samples. Blanching of basil leaves was carried out by steam for 30 seconds before drying,.

Drying Method: Hot Air Tray Dryer

Both unblanched and blanched basil leaf samples were dried in a hot air tray dryer manufactured by by Navrang Scientific Works Pvt. Ltd. Drying experiments were conducted at three different temperatures: 45 °C, 55 °C, and 65 °C. Air velocity inside the drying chamber were kept constant during the experiments.

A fixed sample weight (e.g., 100 g) was spread uniformly in a single layer on stainless steel drying trays. The drying process continued until the samples reached a constant weight, corresponding to the target final moisture content (~5% d.b.). The sample weight was recorded at regular intervals using a precision digital balance (±0.01 g accuracy).

Moisture Content Determination

Initial and final moisture content of the basil leaves was determined using the oven drying method at 105 °C for 24 hours and expressed on a dry basis (d.b.) as per standard procedure.

Drying Rate Calculation

The drying rate (% d.b./min) at each time interval was calculated using the formula:

Accordingly the average drying rates at different timings during the low temperature drying were computed in all experimental conditions using following relationship:

$$\frac{dM}{dt} = \frac{(M_t - M_{t+\Delta t})}{\Delta t}$$

Where,

$\frac{dM}{dt}$ = Average drying rate, % d.b. /minute

t = time at any instant, minute

t + Δt = time after an interval of Δt, minute

The arithmetic decrement in drying rate was calculated as the difference between the initial and final drying rates during the entire drying process for each temperature and treatment.

Data Analysis

Drying curves and drying rate graphs were plotted using Microsoft Excel. Drying characteristics were compared across different treatments to analyze the effect of blanching and drying temperature.

III. Result and Discussion

Hot Air Tray Drying of Basil Leaves

Basil leaves were dried using a hot air tray dryer set at three different temperatures: 45 °C, 55 °C, and 65 °C. The drying process continued until the leaves reached a pre-determined final weight, corresponding to the desired moisture content of the dried product. The variation in moisture content over time during drying for both blanched and unblanched basil leaves is illustrated in Figures 1 to 3, respectively, for each temperature setting.

The results clearly indicate that drying time decreased with increasing temperature. This trend was more pronounced in blanched samples, particularly at 45 °C and 55 °C, where blanching significantly reduced the drying duration. However, at 65 °C, the difference in drying time between blanched and unblanched samples was relatively less noticeable. In all cases, the initial phase of drying exhibited a rapid moisture loss, which gradually slowed over time as drying progressed, consistent with typical drying behavior.

For blanched basil leaves, the initial moisture contents of 442.55%, 472.22%, and 436.84% (d.b.) were reduced to 4.61%, 5.56%, and 5.26% (d.b.) in 180, 120, and 90 minutes at 45 °C, 55 °C, and 65 °C, respectively.

In contrast, unblanched samples with initial moisture contents of 426.32%, 437.63%, and 434.76% (d.b.) required 600, 300, and 150 minutes to reach final moisture levels of 5.26%, 5.74%, and 5.17% (d.b.) at the same respective temperatures.

These results confirm that drying at 45 °C required significantly more time to reduce the moisture content compared to drying at higher temperatures. The accelerated moisture removal at 65 °C can be attributed to a faster movement of the drying front and higher evaporation rates due to increased thermal energy. This effect was observed in both blanched and unblanched leaves, although blanching enhanced drying efficiency across all temperatures.

Photographs of the hot air dried basil leaf samples at each temperature are shown in Plates 1, 2, and 3 Notably, blanching had a positive effect on the final color of the dried basil leaves. Unblanched samples appeared dull and discolored, while blanched samples retained a more vibrant green color, closer to that of fresh basil leaves.

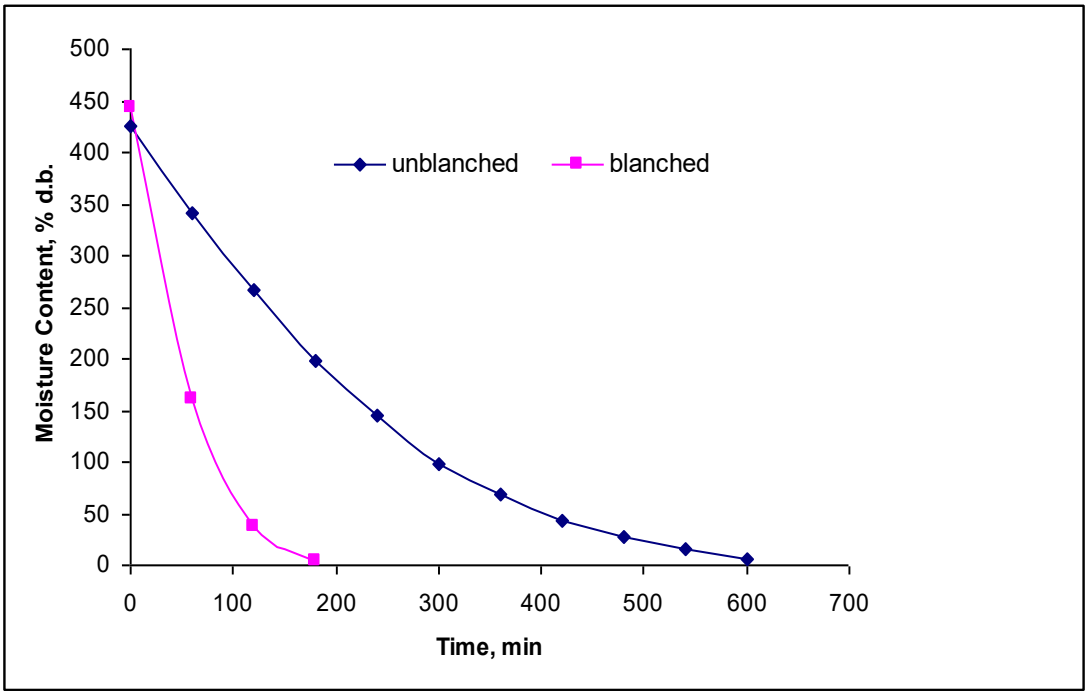

Fig. 1. Variation in moisture content of basil leaves with drying time for hot air tray drying at 45 °C

Plate 1. Basil leaves dried at 45 45 °C in hot air tray dryer

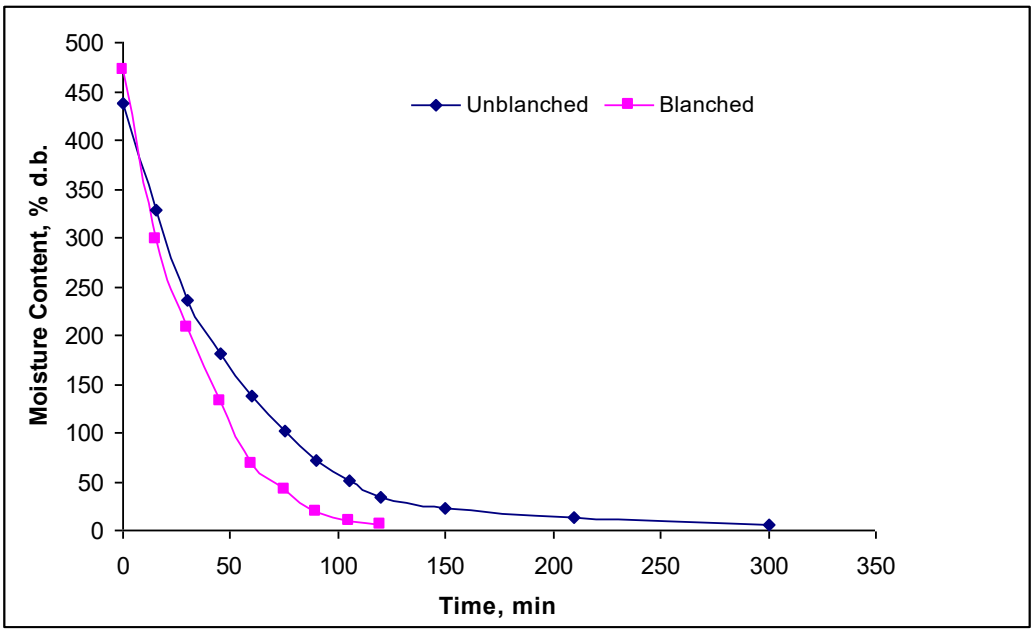

Fig.2. Variation in moisture content of basil leaves with drying time for hot air tray drying at 55 °C

Plate 2. Basil leaves dried at 55 °C in hot air tray dryer

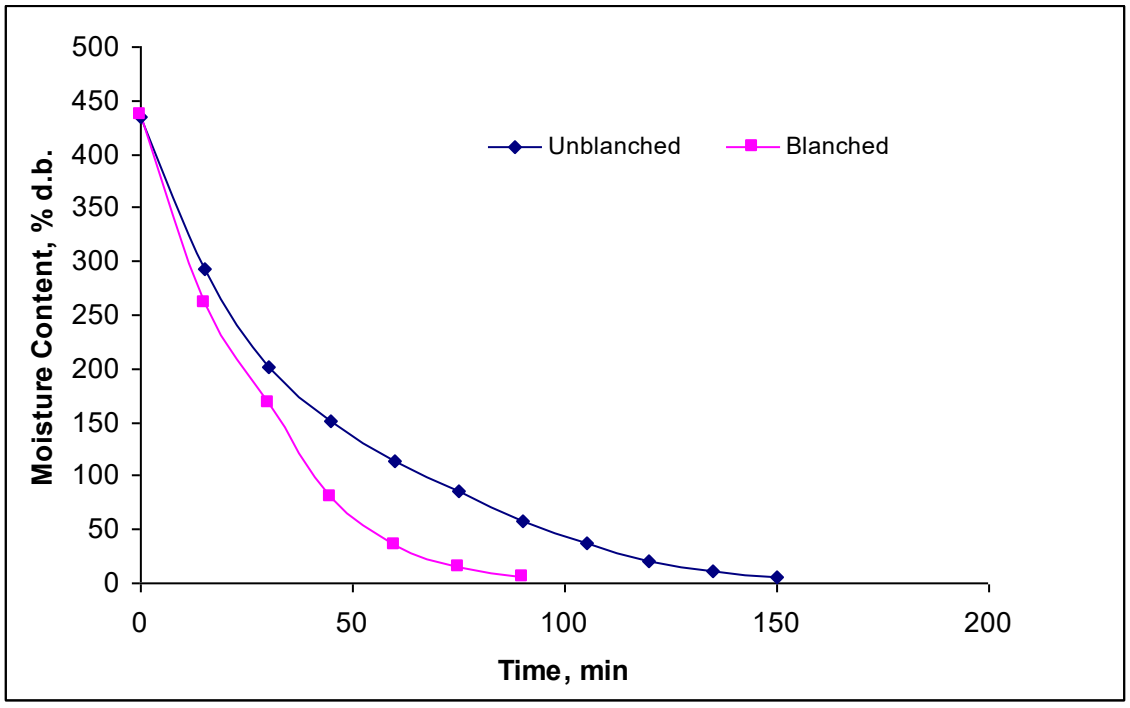

Fig. 3. Variation in moisture content of basil leaves with drying time for hot air tray drying at 65 °C

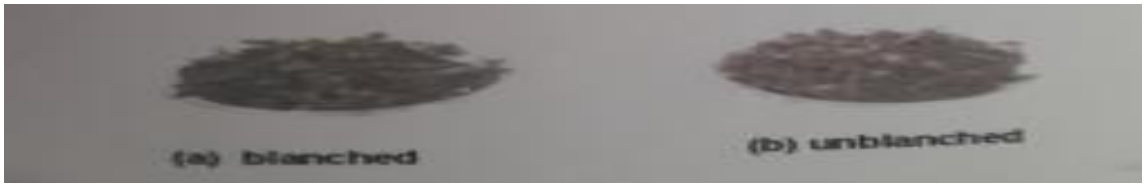

Plate 3. Basil leaves dried at 65 °C in hot air tray dryer

Average Drying Rate

The drying kinetics of basil leaves using a hot air tray dryer were studied at three drying temperatures: 45 °C, 55 °C, and 65 °C, for both unblanched and blanched samples. The drying rate was measured over time, and the arithmetic decrement in drying rate was calculated to assess the influence of blanching and temperature on moisture removal efficiency.

At 45 °C, the drying rate for unblanched leaves decreased from 1.43% to 0.18% d.b./min, resulting in an arithmetic decrement of 1.26% d.b./min. In blanched samples, the drying rate dropped more sharply, from 6.03% to 0.18% d.b./min, with a corresponding decrement of 5.81% d.b./min. This suggests that blanching significantly increased the initial drying rate but also caused a more rapid decline.

At 55 °C, unblanched samples showed a drying rate reduction from 7.29% to 0.80% d.b./min, while blanched leaves experienced a decrease from 11.61% to 0.25% d.b./min. The arithmetic decrement was 7.21% d.b./min for unblanched and 11.36% d.b./min for blanched samples, indicating a substantial enhancement in drying efficiency due to blanching at this intermediate temperature.

At 65 °C, the drying rate of unblanched samples declined from 9.51% to 0.36% d.b./min, while blanched leaves decreased from 11.70% to 0.70% d.b./min. The calculated decrements were 9.15% d.b./min and 10.99% d.b./min, respectively.

These results confirm that blanching pretreatment improves the initial drying rate across all temperature conditions but also leads to a sharper reduction in drying rate over time, especially evident at 45 °C and 55 °C. Additionally, higher temperatures (such as 65 °C) accelerated drying in both treatments, although the relative impact of blanching diminished slightly at this level.

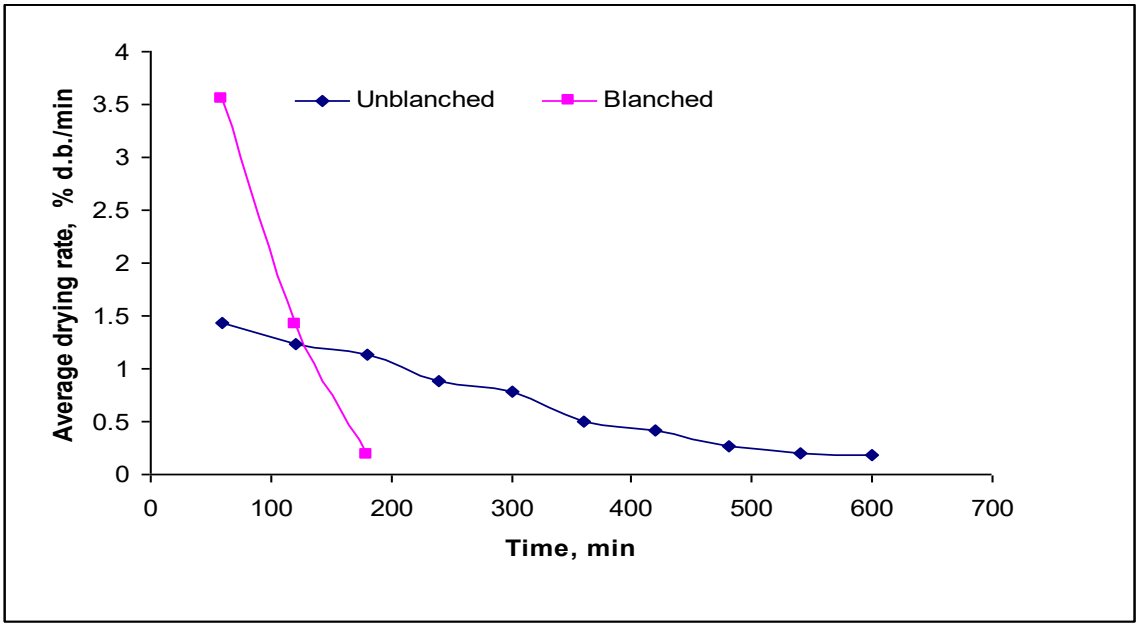

Fig. 4. Variation in average drying rate of basil leaves with drying time for hot air tray drying at 45 °C

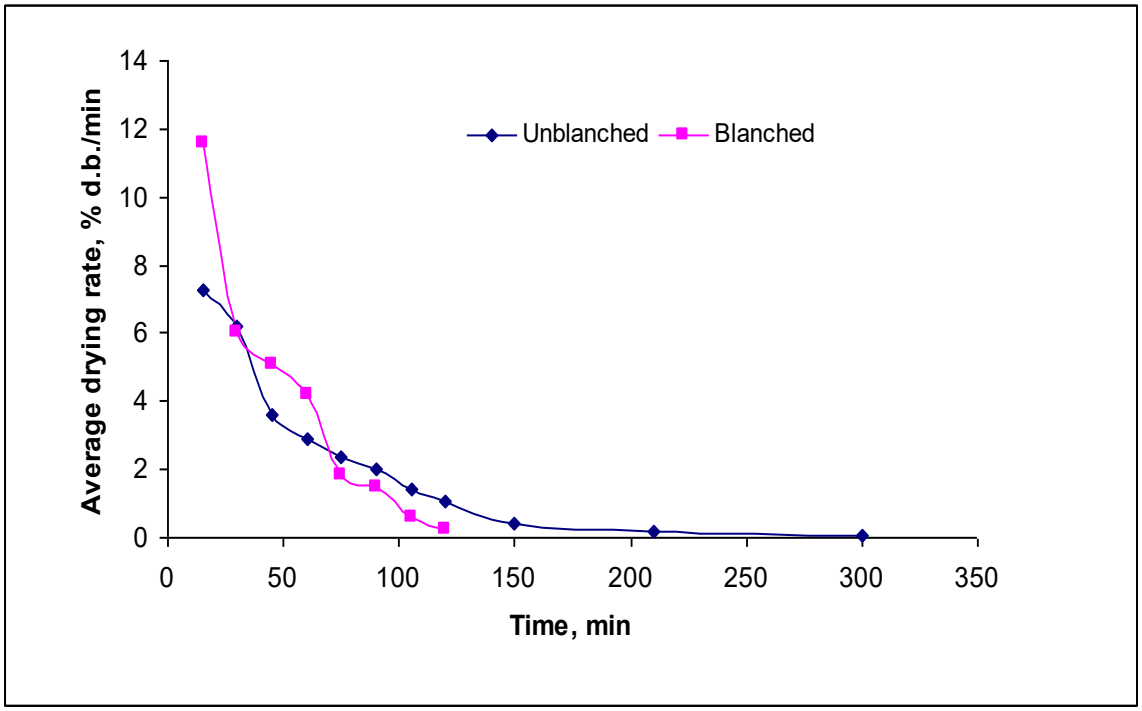

Fig.5 . Variation in average drying rate of basil leaves with drying time for hot air tray drying at 55 °C

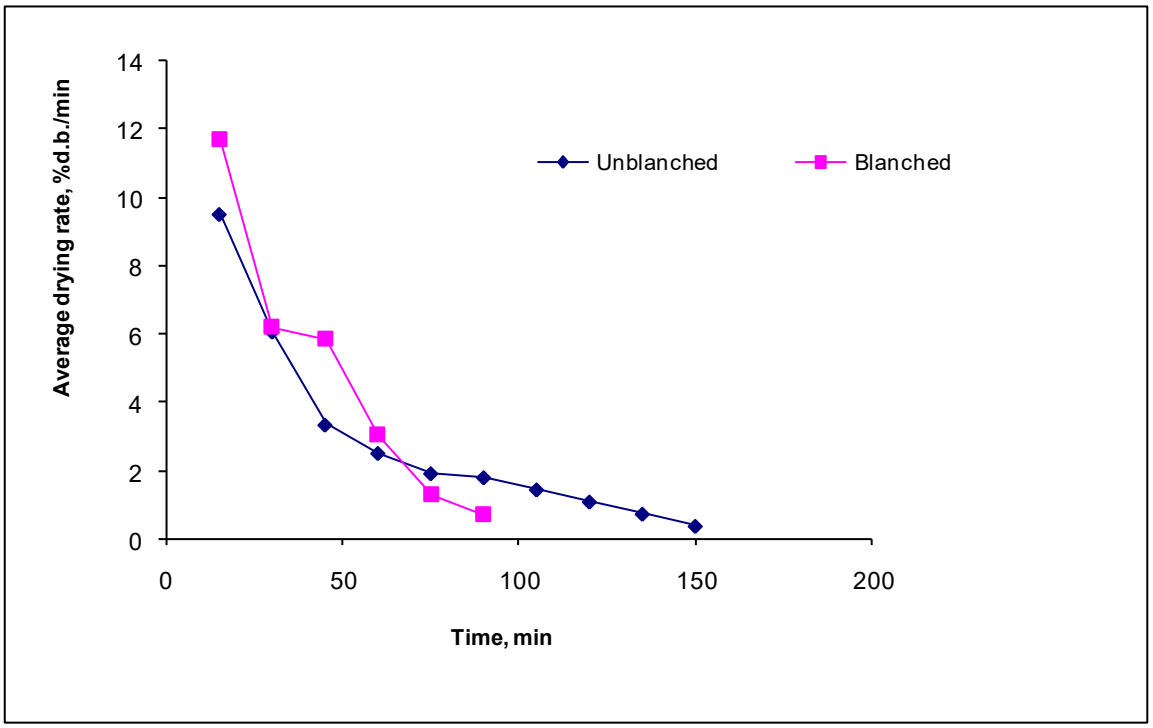

Fig. 6. Variation in average drying rate of basil leaves with drying time for hot air tray drying at 65 °C

IV. Conclusion

The study demonstrated that both drying temperature and blanching pretreatment significantly influenced the drying behavior of basil leaves in a hot air tray dryer. An increase in drying temperature from 45 °C to 65 °C reduced the total drying time and increased the initial drying rate for both unblanched and blanched samples.

Blanching pretreatment led to a higher initial drying rate due to enhanced moisture diffusivity but also resulted in a more rapid decline in drying rate over time. The arithmetic decrement in drying rate was

consistently higher in blanched samples across all temperatures, with the most significant difference observed at 55 °C, suggesting this temperature may offer an optimal balance between drying efficiency and product quality.

Overall, the results suggest that blanching combined with hot air drying at moderate to high temperatures can significantly improve drying performance and potentially preserve the color and quality of basil leaves better than drying unblanched samples.

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