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Retention of active ingradients in hot air tray drying

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***Abstract**: Drying is by far the most widely used treatment, which needs to be performed very carefully and preciously so as to preserve the aroma and color of the leaves. Drying treatment and experimental method hot air tray drying was carried out at the temperatures of 45°C, 55°C and 65°C to find and suggest the optimum drying condition for acquiring quality dried basil leaves and active ingradientl like uginol , caryophyll of basil leaves..Results have revealed that 'total drying time' is considerably reduced with the increase in drying air temperatures from 45°C to 65°C. It could be recommended that for the best drying temperature is 45°C of basil leaves to retain the various active ingradient,*

***Keywords:** drying, drying characteristics, basil leaves, hot air tray drying, active ingradient*

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I. Introduction

Proper drying of basil leaves or any such material, is not only improving the quality of product, but also reducing various costs involved in its processing, marketing. The major focus for drying such leaves often remained centered around a point where its aroma needs to be preserved beside the appearance and nutritional characteristics. Researchers (Diaz-Marotoet al., 2002; Brophy et al., 1986; Fleisher, 1981) have reported that improper drying may cause losses in volatilities or formation of new volatilities as a result of oxidation and esterification reactions. The volatile composition of basil is found to be dependent on the variety and/or geographical cultivation of the basil plant depending upon main components (Linalool, methyl cinnamate, eugenol, methyl eugenol, and etc.) of this precious herb.

The majority of findings have revealed this fact where the drying is reported to influence changes in the volatile compounds present in basil.

If we look from quantitative points of view, these decreases in the total amounts of essential oils have been reported to varied tune, say being 36% to 45% for sweet basil during drying at ambient temperature (Nykanen and Nykanen, 1987; 1989). A study by Yousif et al. (1999) showed significant difference in concentrations of linalool and methyl chavicol in air-dried basil samples compared to those present in fresh samples, while that of vacuum dried samples showed substantial increase of about 2.5 fold for linalool and 1.5 fold for methyl chavicol, compared to that present in air-dried samples. Di Cesare et al. (1994; 2000; 2001; 2002; 2003) found microwave drying to retain high percentages of characteristic volatile compounds (eucalyptol, linalool, eugenol, and methyl eugenol) in basil (Ocimum basilicum L.) compared to samples dried by air-drying and freeze-drying with blanching, except freeze-dried unblanched leaves. Other studies on drying methods on volatilities of leaf (Diaz-Maroto et al., 2002), and spearmint (Diaz-Maroto et al., 2003) too have given such logical variability.

For that a study on temperature effect in fluidized bed drying for drying and phytochemicals of basil leaves was carried out .

Yuparat et al. (2014) utilized some of the predictive models to evaluate the performances as well as influences of certain parameters towards drying of leaves and other similar materials by fitting prevailing moisture versus time data to five different crop drying models. The drying constants were well related to the drying temperatures. The ultimate findings of Abdollah et al. (2014) reflected the facts that (1) drying temperatures can decrease essential oil contents of basil, (2) drying methods can change the chemical profile of essential oil of basil, and (3) oven drying at 40^0C had the least effect on essential oil.

Looking into plethora of such studies and their findings towards temperature effects on drying and volatile components of basil leaf, present research was conceived and conducted in India whose preliminary results are reported herein. The major aim of the work was to examine the influence of various drying methods and retention of phytochemical on a couple of crop varieties as cultivated in India, leaves cultivated in this specific region of India, to promote its market/utility and also to maintain its nutritional value and other qualitative parameters in an optimum manner.

II. Materials And Methods

2.1 Materials and Equipments

Basil plants were grown in the campus.. The variety of basil grown for the experiment was the green basil. In the green basil, varieties were kept same as far as possible. The plant leaves were manually nibbed from the basil plant and cleaned with water spray at evening so as to remove dust and other impurities. Soft stem were separated from the leaves manually if left during nibbing. Care was taken to avoid bruised and discoloured leaves.

For drying of basil leaves hot air tray dryer was used. For chemical analysis, clevenger type apparatus for volatile oil measurement and GC-MS for active ingredients determination were used.

2.2 Blanching

In preliminary experiment hot water blanching was carried out using the method described by Ranganna (1986) for catalase and peroxidase analysis.

2.3 Measurement of Variables

Methods used to measure different variables are described below:

2.3.1 Air temperature

Air temperature was measured using mercury thermometer (capacity: 0 – 110 °C, least count: 1°C) as well as digital temperature recorder (capacity: 0 – 200 °C, least count: 0.1°C). The air temperature was controlled within ±0.1°C during the experiment by adjusting the thermostat.

2.3.2 Air velocity

Air velocity was determined by using the digital anemometer (Agrawal Electronics, Mumbai-Model 8903). The velocity range of anemometer was 0.1- 35.0 m/s. Air velocity was kept 2 m/s in the fluidized bed dryer.

2.3.3 Moisture content

Average drying rate

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

$$\frac{dM}{dt} = \frac{(M_t - M_{t+\Delta t})}{\Delta t} \qquad \text{.....(3.4)}$$

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

2.4 Experimental Procedure

2.4.1Cleaning

Fresh basil leaves were taken from the plants grown in campus and thoroughly cleaned before manual nibbing. The soft stems were removed and basil leaves were separated and cleaned manually to remove soil and dust particles if any attached to it.

2.4.2 Sample preparation

Cleaned basil leaves were weighed in digital balance (Simanzu make, Capacity: 220 g, least count: 0.01 g). Samples were prepared and placed in tray for hot air tray dryer.. The sample weight kept in each dryer was 100 g.

2.4.3 Pretreatment of sample

Weighed basil leaves were pretreated by steam blanching for 30 second**s** by keeping them in a sieve above the boiled hot water to receive the steam coming from it.

Steam blanched samples were placed over a perforated tray to separate the stuck leaves during steaming. After that weight sample of leaves was loaded into wire basket in fluidized bed dryer. Fresh sample without pretreatment was used as control

2.5 Drying methods used

The drying of basil leaves was carried out using hot air tray dryer. Treatment was carried out with samples in triplicate.

Each 100 g blanched and unblanched samples were uniformly spread in wire basket for fluidized bed dryer and dried at the desired temperature. The moisture loss was recorded at every 60 min interval using top pan digital balance.

2.5.1 Hot air tray drying

Drying experiments were performed in a cabinet type laboratory hot air tray dryer, manufactured by Navrang Scientific Works Pvt. Ltd., New Delhi and fitted with manually controlled digital thermostat, PT-100 thermocouple, a blower driven by 0.5 hp motor and electric finned heaters of 3x1 kW. The dryer was adjusted to the selected temperature (45, 55, 65 °C) for about half an hour before the start of experiment to achieve the steady state condition. Air velocity was set at 1.0 m/s and maintained by adjustable flap throughout drying time and measured by digital anemometer. Then 100 g of pretreated and untreated samples of basil leaves were uniformly spread in the tray.

The moisture loss from the basil leaves was recorded at every 15 minute interval at 55 and 65 °C temperature and one hour interval at 45 °C temperature during drying using top pan digital weighing balance. The drying process was stopped when the final moisture content reached to about 4 – 6 % (db). The product was then cooled for 10 minutes after drying and packed in LDPE bags. All the experiments were conducted in triplicate for each air temperature and pretreatment. The average values are reported

2.6 Estimation of Volatile Oil

2.6.1 Sample preparation

For the estimation of volatile oil in the dried basil leaves, minimum 50 g dried sample was taken. To collect 50 g dried sample, at least 300 g fresh leaves were collected to dry in hot air tray dryer. For duplication total 600 g. Fresh leaves were collected and dried for volatile oil sample analysis.

2.6.2 Determination of volatile oil content

The volatile oil content of basil leaves was estimated as described by the Bureau of Indian Standards (SP: 18(part Vii)-1982)

50 g of basil leaves were transferred into 1 liter round bottomed flask and then water was added to fill the flask slightly less than half full and mixed by swirling. To this few glass beads were also added. The flask was connected through calibrated oil trap to the condenser. The mixture was distilled for four hours until there was no increase in the oil content over a period of 1 hour. The setup was cooled to room temperature and allowed to stand until the oil layer was clear. The volatile oil was collected in the trap, was measured in ml.

2.7 GC - MS Conditions

For the identification of the volatiles compounds, some samples were subjected to GC- MS analysis on a Perkin Elemer Autosystem Excel with Turbomass. Conditions were as follows:

1. Mode: TIC (Total Ion Chromatogram)
2. Column Type: PE- 5 (MS)
3. Column Oven Temperature: 70 °C (5 minute) -80 °C (10 minute)
4. Injector Temperature: 250 °C
5. Detector: Quadrupole
6. Ion Source Temperature: 250 °C
7. Carrier Gas: Helium
8. Flow Rate: 1ml/min
9. Split Ratio: 1: 5

III. Results And Discussion

3.1 Initial Moisture Content

The basil leaves were collected from the plants grown in campus. samples of the fresh basil leaves was 81.68 % (w. b.) at the time of harvest. The range of moisture content varied from 81.00 - 83.00 % (w. b.), which shows that the basil leaves can be considered under highly perishable group.

3.2 Drying Characteristics of Basil Leaves

The drying characteristics of basil leaves were analyzed using the experimental data on moisture of product at various time intervals for different drying conditions. After pretreatment, the samples were dried up to the safe moisture content level of 4 to 6 % (% d.b.).

Relation of time, and drying rate (% d.b./min) was attempted to characterize the drying behaviour of basil leaves. The moisture content was compared for the blanched and unblanched samples with different time, temperature for different dryers.

The basil leaves were steamed and thus had some moisture on the surface of basil leaves due to which blanched shows higher moisture content then actual.

3.3 Average Drying Rate

To analyze the effect of drying conditions on rate of drying, average drying rate was computed for each experiment.

The average drying rate represents the rate of change of moisture content (% d.b.) over a particular time interval and is attributed to the middle of the time interval. The average rate of drying is expected to decrease continuously with the drying time, being faster at higher temperatures except for constant rate drying conditions.

3.3.1 Hot air tray drying

At 45 °C temperature, the drying rate decreased from 1.43 to 0.18 % d.b./min for drying of unblanched basil leaves while from 4.02 to 0.18 % d.b./min for drying of blanched leaves. The arithmetic decrement in unblanched and blanched samples drying at 45 °C temperature was observed as 1.26 % d. b./min and 5.81 % d.b./min, respectively.

At 55 °C temperature, the drying rate decresed from 7.29 to 0.8 d. b./min for drying of unblanched samples, while from 11.61 to 0.25 % d.b./min for blanched leaves. The arithmetic decrement in unblanched and blanched samples at 55 °C temperature was observed as 7.21 % d. b. /min and 11.36 % d.b./min, respectively.

At 65 °C temperature, the drying rate decreased from 9.51 to 0.36 % d. b./min for drying of unblanched sample while from 11.70 to 0.70 % d.b./min for drying of blanched leaves. The arithmetic decrement in unblanched and blanched samples at 65 °C temperature was observed as 9.15 % d. b./min and 10.99 % d.b./min, respectively.

The drying rate decreased from 1.43, 7.29 and 9.51 % d. b./min to 0.18, 0.08 and 0.36 % d. b./min for drying of unblanched basil leaves, while from 6.03, 11.61 and 11.70 % d. b./min to 0.18, 0.25 and 0.70 % d.b./min for the drying of blanched basil leaves at 45, 55 and 65 °C temperature, respectively. This shows that as temperatures increases the drying rate also increases.

This showed that the drying rate was rapidly decreasing in the blanched sample than the unblanched sample at 45, 55, 65 °C temperatures, respectively. The trend of variation of drying rate with time is shown in Figs. 1,2 and 3 for blanched and unblanched drying for 45, 55 and 65 °C temperature, respectively.

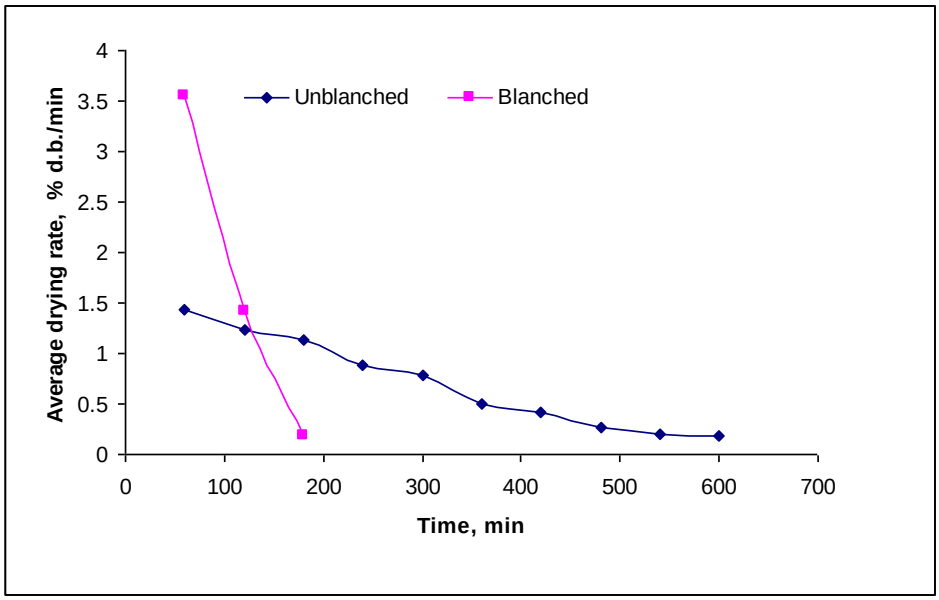

Fig. 1. : Variation in average drying rate of basil leaves with drying time for hot air tray drying at 45 °C

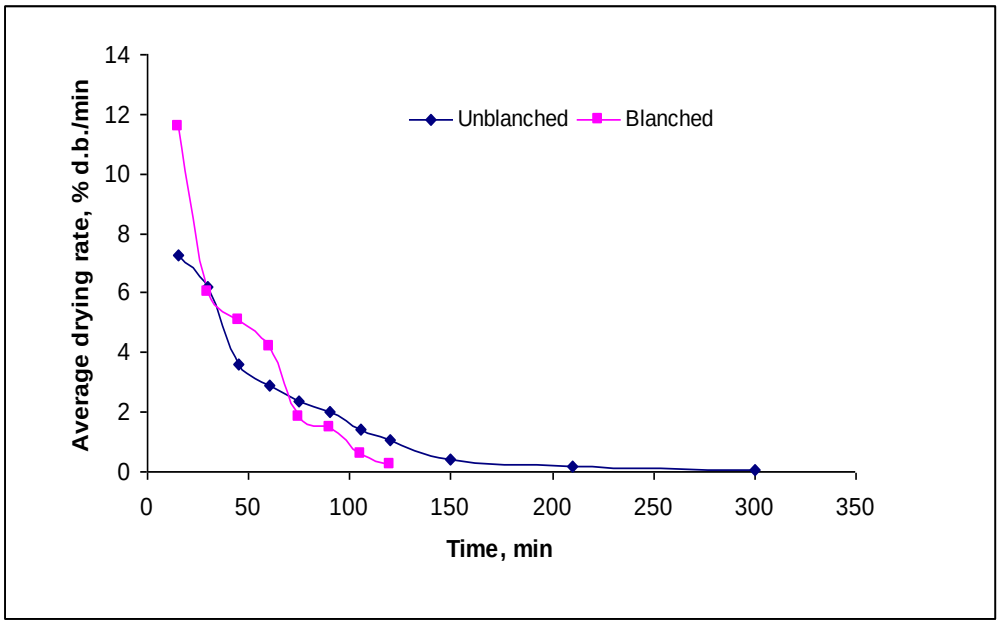

Fig. 2. : Variation in average drying rate of basil leaves with drying time for hot air tray drying at 55 °C

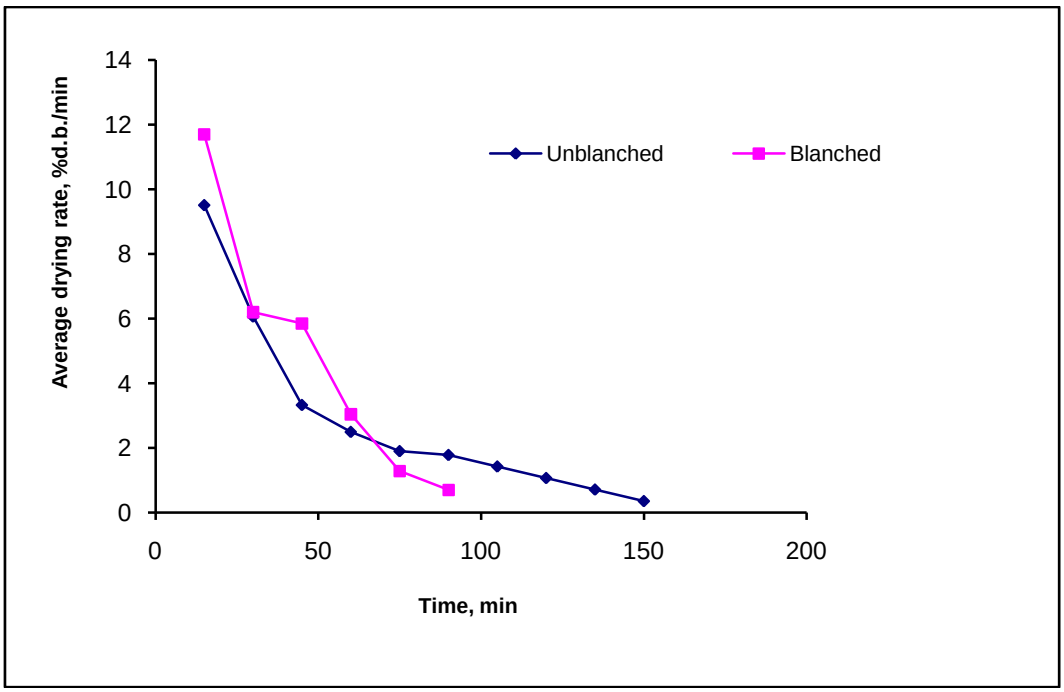

Fig. 3. : Variation in average drying rate of basil leaves with drying time for hot air tray drying at 65 °C

3.4 Effect of Drying Conditions on Volatile Oil Content

Volatile oil content of dried basil leaves is presented in Table 1. It showed that volatile oil of samples varied from 0.39 to 0.65 ml/100g d.m. In case of unblanched samples, oil content loss was less as compared to blanched sample. This might be due to the oil content loss during the blanching treatment. In hot air drying of basil leaves at 45, 55 and 65 ^{0}C temperatures, the volatile oil content was found as 0.65, 0.56 and 0.39 ml/100g d.m., respectively, in the unblanched samples. Whereas, 0.63, 0.50 and 0.39 ml/100g d.m., respectively, in case of blanched samples. The volatile content of fresh sample was 1.36-ml/100g d.m. The loss of volatile oil content was very high ranging from 71.43 % (blanched,) to 71.43 % (unblanched) for hot air drying at 65 °C. Loss of volatile oil content was higher when basil leaves were dried at higher temperature. This might be because of the breakage of oil cell due to heating, which leads to loss of volatile oil. It was also observed that although at higher temperature the drying time was shorter, the loss of volatile oil was higher.

From the Table 1 it was revealed that volatile loss was minimum (53.68 % d.m. in the blanched samples) at the 45 °C temperature in the hot air tray dryer, in unblanched samples loss was minimum to 52.21 %.

Table 1.: Experimental data on volatile oil content on dried basil leaves

Type of dryer	Temperature (°C)	Treatment Unblanched (UB) / blanched (B)	Volatile oil (ml/100 g d.m.)	Loss in Volatile oil (%)
Hot air dryer	45	UB	0.65	52.21
		B	0.63	53.68
	55	UB	0.56	58.83
		B	0.50	63.24
	65	UB	0.39	71.43
		B	0.39	71.43

3.5 Effect of Drying Conditions on Active Ingredients

Blanching resulted into the good colour. Hence, blanched samples were taken for further GC-MS analysis to identify the volatile compounds in the fresh basil leaves and as well as in blanched basil leaves dried at the temperature 45, 55 and 65 °C in the hot air dryer..

Fig 4 shows a typical chromatogram obtained from a fresh sample from GC-MS analysis and Table 2 shows the percentage composition of the identified compounds as calculated from the respective chromatographic areas. There are, mainly eugenol (61.69 %) and in minor proportion caryophyllene (28.77 %) remaining peaks correspondence to compounds that were not identified.

Table 2 : Active ingredients available in fresh basil leaves

Peak	Compound	Area (%)
1	Eugenol	61.69
2	Caryophyllene	28.77

The two major volatile compounds in fresh basil leaves samples were eugenol and caryophyllene usually considered responsible for the typical basil aroma as per figure 4. Similar results were reported by (Anon.,1966). The area under the chromatographic peaks of the other compounds is small.

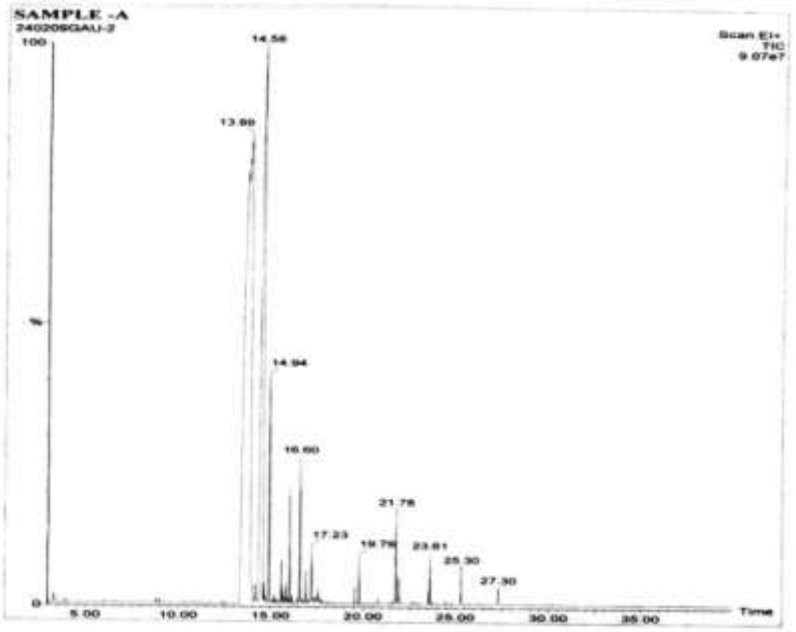

Fig. 4. Gas chromatograph of fresh basil leaves

3.5.1 Effect of drying conditions on eugenol compound

Table 3 shows the eugenol percentage in the dried blanched basil leaves in hot air tray drying at 45, 55 and 65 °C temperature. In the fresh basil leaves eugenol was 61.69 % and Caryophyllene was 28.77 %.

As shown in figure 5, in the hot air tray drying of blanched basil leaves, the eugenol was observed 45.01% at 45 °C temperature, 28.69 % at 55 °C temperature and 26.21% at 65 °C temperature, which indicates that as temperature increases, the eugenol was decreases. The percentage loss was 26.98 %, 53.49 %, and 57.31 % at 45, 55 and 65 °C temperatures, respectively.

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Table .3 : Eugenol content in the dried basil leaves

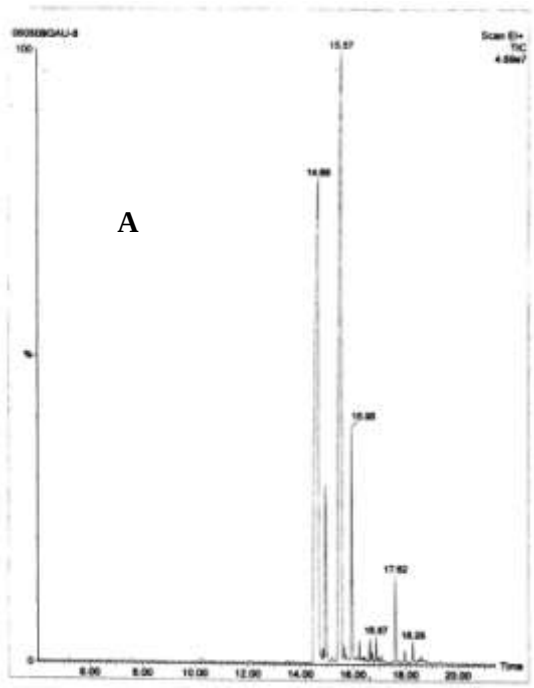
Type of dryer	Temperature (°C)	Treatment Blanched (B)	Eugenol Content in fresh leaves (%)	Eugenol content in dried leaves (%)
Hot air tray dryer	45	B	61.69	45.01
	55	B	61.69	28.69
	65	B	61.69	26.21

3.5.2 Effect of drying conditions on caryophyllene compound

The percentage retentions of the second major volatile compound i.e caryophyllene in the blanched basil leaves was less in lower temperature than the higher temperature in hot air drying are reported in Table 4. It shows that as compared to caryophyllene in the fresh sample of basil leaves it increased in basil leaves dried in all the temperature as per figure 5.. This trend was observed similar to trend observed by Mondal (2007).

Table 4. : Caryophyllene content in the dried basil leaves

Type of dryer	Temperature (°C)	Treatment Blanched (B)	Caryophyll Content in fresh leaves (%)	Caryophyll content in dried leaves (%)
Tray dryer	45	B	28.77	43.13
	55	B	28.77	43.68
	65	B	28.77	40.52



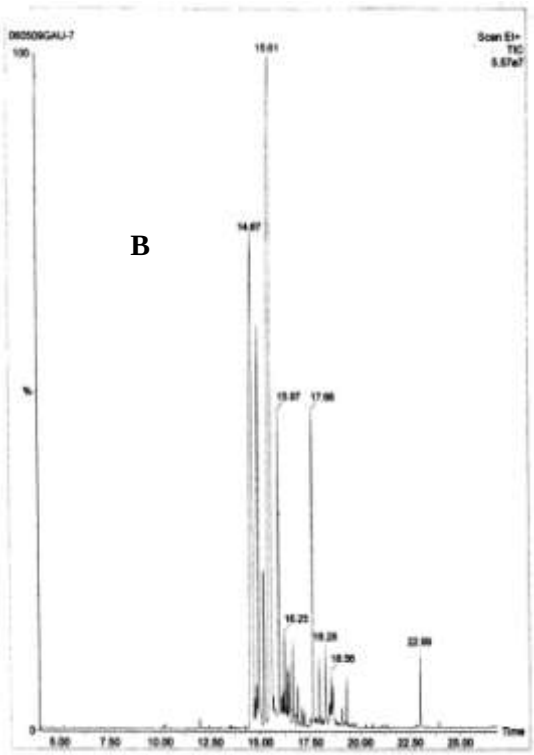


Fig. 5 Eugenol and caryophyllene content of hot air tray dried basil leaves at different temperatures: (A) 45 °C; (B) 55°C and (C) 65 °C

IV. Conclusions

The present investigation entitled "retention of active ingradients" was carried out to develop dried basil leaves / powder so as to enhance the availability of basil leaves / powder in lean period. Basil leaves were steam blanched for 30 second for pretreatment. The blanched and unblanched samples of 100 g weight were loaded in hot air tray dryer at temperature 45, 55 and 65 °C. Unblanched basil leaves were dried as control samples. The effect of drying conditions on, volatile oil was also investigated. The active ingredients in basil leave viz. eugenol and caryophyllene were also studied. On the basis of experimental results and data analysis the following conclusions are drawn given as under.

1. Total drying time considerably reduced with the increase in drying air temperature from 45 °C to 65 ° C temperatures.
2. The whole drying took place in falling rate period only.
4. Blanched sample took less time for drying compared to unblanched samples in each dryer at every temperature from 45, 55 and 65 °C temperature.
5. Volatile oil was found slightly less in the blanched samples in comparison to unblanched samples of basil leaves.
7. Volatile oil was higher at lower temperature and decreased at higher temperature.
9. Eugenol was found as major active ingredient in the fresh sample of basil leaves, while caryophyllene was the second major active ingredient.
10. In the dried basil leaves, the caryophyllene increased, while eugenol decreased most at higher temperatures.

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