International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org ||Volume 7 Issue 1|| January 2018 || PP. 34-44

Temperature Effect on Drying And Phytochemicals of Basil Leaves

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Abstract: *Basil is a most popular aromatic and annual herb. Immediately after its harvesting, the highly perishable raw material, i.e. leaves, have to be preserved against deterioration and spoilage. More often, during peak period, most of the crop is lost/wasted due to lack of proper post-harvest processing techniques. 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 fluidized bed 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 phytochemical 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 phytochemicals., fluidized bed dryer at 45ºC for 30 seconds steam blanched sample ensuring the best results in quality and phytochemicals of basil leaves.*

Keywords: *drying, drying characteristics, basil leaves, fluidized bed drying, phytochemicals*

Date of Submission: 05-01-2018 Date of acceptance: 30-01-2018

I. Introduction

The use of basil and other spicy herbs in food preparations are not just only for flavoring from their strong spicy aroma, but also for other purposes such as their medicinal, antioxidant, anti-inflammatory, antiviral or antimicrobial properties (Risch, 1997). Proper drying of this important crop happens to be the most common and effective method that could vastly increases the shelf life of such spicy herbs by inhibiting the growth of microorganisms and preventing the onset of some biochemical reactions. It ultimately may alter the organoleptic and nutritional characteristics of dried leaves. Basil crops stored at high moisture content generally get deteriorated because of microbiological growth. One of the most common preservation methods to avoid such conditions or scenarios for herbs and spices remains drying. 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 and other in tangible means. For situations like India, the transport and storage costs are amply high, which could be significantly lowered after proper drying operations of such crops. It happens because of the reason that weight and volume gets drastically reduced to facilitate the storage and transport of leaves at lower costs. This altogether established the importance of drying for basil and alike medicinal crops. Since this process consists simultaneous heat and moisture transfers which inevitably requires various kinds of systems, crops and their varieties have different structures, shapes and characteristics and therefore, they have altogether different drying behaviors. Understanding these drying behaviors and their proper planning and conductance undoubtedly remained one of the biggest needs for the growers and accordingly a big challenge for the researchers. 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.

In general type, variety and production practices of the crop, its chemical composition and susceptibility to heat treatment, pretreatment given, method and conditions of drying and climatic conditions are important factors affecting drying. Consumers prefer processed products that keep more of their original characteristics. For that a study on temperature effect in fluidized bed drying for drying and phytochemicals of basil leaves was carried out .Amin et al. (2013) conducted certain drying experiments at varied air temperatures and offered a Genetic Algorithm which could find the best Feed-Forward Neural Network (FFNN) structure to model the moisture content of dried Basil in most of the conditions. This ultimately facilitated better predictions of moisture content of dried basil leaves, which in turn has direct impacts on drying of basil leaves. 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, in particularly its western part nearing state of Gujarat. At least two varieties of *Ocimum sanctum* are mostly found in cultivation, out of which the green type (Sri Tulsi) is the most widespread. The other one known as Krishna Tulsi, bears purple leaves (Anon., 1966) and has equal importance and considerations in the region. The results of this study have provided ample food for visualizing and adopting most effective drying method for basil 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

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 fluidized bed dryer was used. For chemical analysis, pH meter for pH determination, spectrophotometer for chlorophyll content determination, clevenger type apparatus for volatile oil measurement and GC-MS for active ingredients determination were used.

Blanching:

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

Measurement of Variables:

Methods used to measure different variables are described below:

Air temperature:

Air temperature was measured using 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.

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.

Moisture content:

The method described in AOAC (1990) was used to determine the moisture content. A metallic dish was dried in oven at 110 °C for a period of one hour. It was quickly covered, cooled in desiccator and weighed (W_1). A 5 g sample was kept in thin layer on the metallic dish and weighed as quickly as possible to avoid loss of moisture (W_2). The sample was kept in hot air oven maintained at 100 $\pm$ 5 °C. The sample was dried for about 4 h until two to three consecutive weights remained constant and final weight was recorded (W_3). The moisture content was calculated using the formula:

$$\% \text{ Moisture content} = \frac{[(W_2 - W_1) - (W_3 - W_1)] \times 100}{(W_3 - W_1)} \quad \ldots\ldots\ldots\ldots \quad (3.1)$$

Where,

W_1 = Weight of empty metallic dish, g
W_2 = Weight of metallic dish with sample, g
W_3 = Weight of metallic dish with dried sample, g

Experimental Procedure:

Basil leaves were subjected to drying at various temperatures were studied in term of chlorophyll content, volatile oil and pH characteristics of dried samples. The flow chart of basil leaves drying is explained in Fig.

Cleaning:

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.

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 wire basket for fluidized bed dryer.. The sample weight kept in each temperature was 100 g.

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

Fig 1: Flow chart of basil leaves drying

Drying Methods Used :

The drying of basil leaves was carried out using fluidized bed 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.

Fluidized bed drying:

The drying experiments were performed in laboratory fluidized bed dryer Plenum chamber of dryer consists of a truncated conical base having bottom diameter of 0.21 m and top diameter of 0.30 m. The height of cylindrical column is 0.73 m. An air supply unit to fluidize the sample is provided at the bottom with centrifugal blower coupled with three phase 1 hp electric motor and a flow regulating device to regulate the air flow rate. Air is heated with two electric heaters of 1 kW each to regulate the temperature of hot air. The blanched and unblanched basil leaves samples (100 g) each were dried by spreading them in single layer in the perforated wire basket placed in the plenum chamber. The hot air was supplied through the bottom of the plenum chamber at the specified temperature (45, 55, 65 °C) and at 2 m/s air velocity. This air velocity was maintained using adjustable flab at the air inlet and measured with digital anemometer. The moisture loss from the leaves was recorded at every 15 min interval during drying using top pan digital weighing balance. The drying process was stopped when the 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.

Packing of dried leaves:

The dried basil leaves were packed in LDPE bags (film thickness 95 micron) sealed air – tight and stored at room temperature till used for analysis.

Extraction and Estimation of Chlorophyll from Leaf Tissue:

Total chlorophyll present in the dried basil leaves was measured using following method described by Hiscox and Israelstam (1979):The chlorophyll pigment of the plant leaf (material) was extracted with dimethlyl sulphide (DMSO) and estimated spectrophotometrically at 663 and 645 nm as chlorophyll 'a' and 'b' absorbs this wavelength..

Estimation of Volatile Oil:

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 fluidized bed dryer. For duplication total 600 g. Fresh leaves were collected and dried for volatile oil sample analysis.

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 as shown in Plate 3.7

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

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.

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, temperature, moisture content (% d.b.) and drying rate (% d.b./min) were 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.

Fluidized bed drying:

It was found from the Figs. 3.3.1 to 3.3.3 that the fluidized bed drying took less time in higher temperature than the lower temperature in the blanched and unblanched samples at the 65, 55 and 45 °C temperatures respectively.. It was also observed that the moisture reduction was more in the blanched leaves than the unblanched leaves drying for all the temperatures.The effect on drying time was found more prominent with blanched than the unblanched samples for the temperature 45 and 55 °C. However, at higher drying air temperature of 65 °C, the effect of blanching on drying time was comparatively less. It was also observed that moisture reduction was rapid initially, which decreased with time in later part of drying for both blanched and unblanched samples to all the temperatures. The effect of drying air temperature on drying behaviour of basil leaves for blanched and unblanched samples indicate that as inlet temperature increased, the rate of moisture reduction also increased.

As data plotted in curves presented in the below figures, it was observed that for 45 °C, the initial moisture content 437.63 % (d.b.) was reduced to 5.74 % (d.b.) in 240 minute and initial moisture content 476.27 % (d.b.) reduced to 5.46 % (d.b.) in 120 minute for unblanched and blanched basil samples, respectively, whereas for temperature 55 °C, the initial moisture content 426.32 % (d.b.) was reduced to final moisture content to 5.26 % (d.b.) in 135 minute and initial moisture content 473. 03 % (d.b.) reduced to 4.87 % (d.b.) in 75 minute for unblanched and blanched on drying behaviour of basil leave The effect of temperature was found more prominent for blanched basil leaves. The initial moisture content 476.27, 473.03, and 473.03 (% d.b.) were reduced to final moisture content of 5.46, 4.87 and 4.87 (% d.b.) in 120, 75, and 60 minute for 45, 55 and 65 °C temperatures respectively. In the case of unblanched samples, the initial moisture 437.63, 426.32 and 449.45 (% d.b.) were reduced to final moisture content of 5.74 %, 5.26 % and 4.37 (% d.b.) in 240,135 and 75 minute for 45.55 and 65 °C temperatures, respectively. At temperature 45 °C the colour was like very much similar as the fresh samples and at the 55 and 65 °C temperatures, colour, appearance and texture are also good in the blanched samples.

Fig.3.3.1 : Variation In Moisture Content Of Basil Leaves With Drying Time For Fluidized Bed Drying At 45 °C

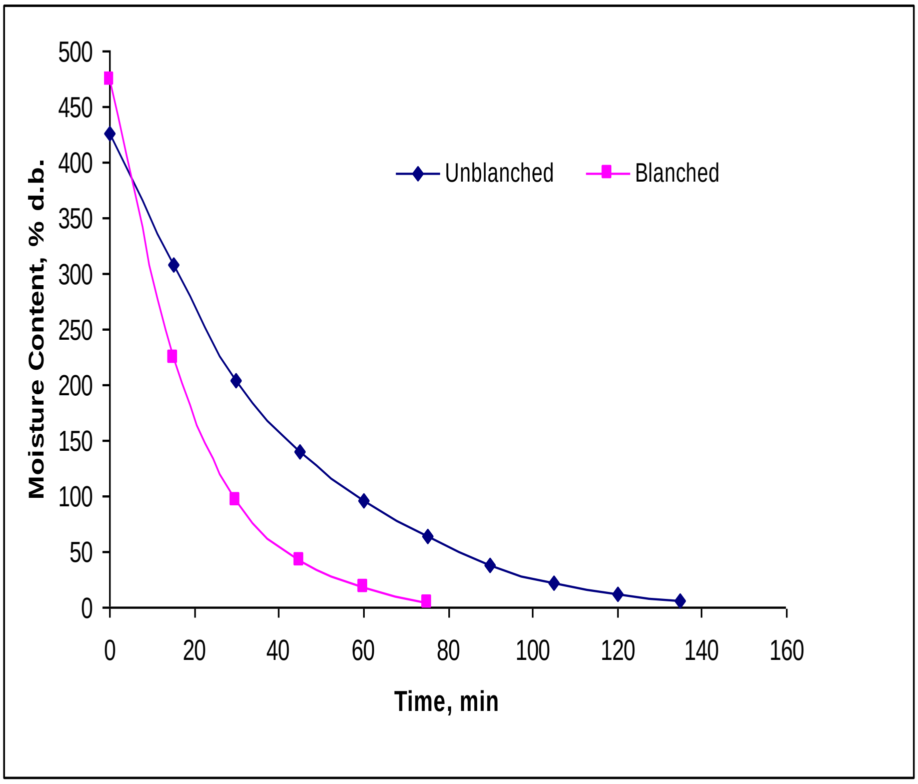


Fig. 3.3.2 : Variation In Moisture Content Of Basil Leaves With Drying Time For Fluidized Bed Drying At 55 °C

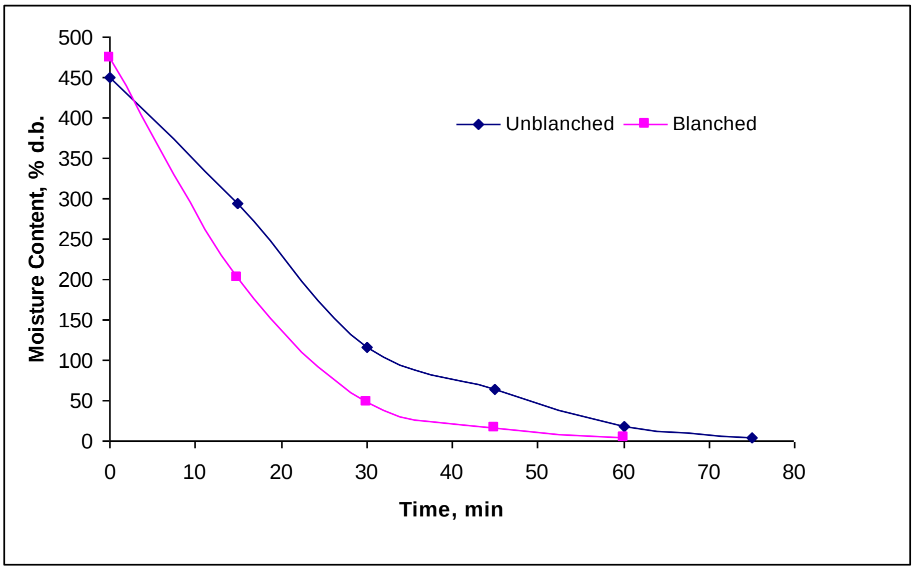
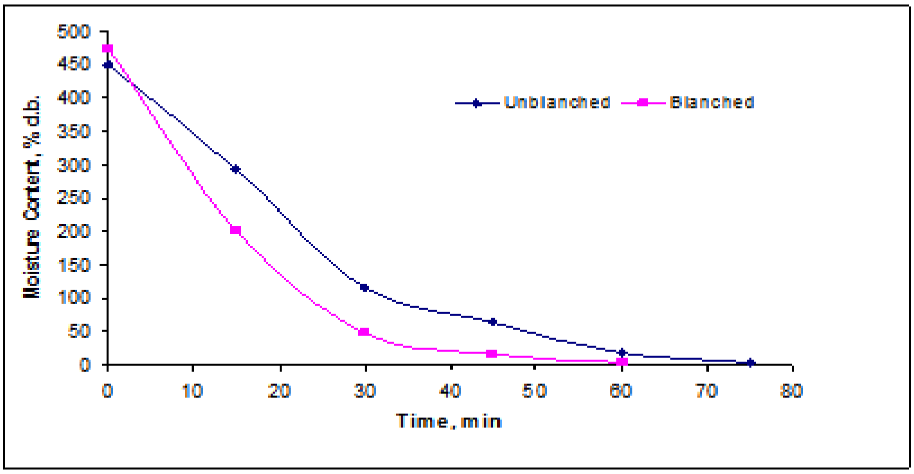


Fig. 3.3.3 : Variation In Moisture Content Of Basil Leaves With Drying Time For Fluidized Bed Drying At 65 °C



Effect Of Drying Conditions On Chlorophyll Content Of Basil Leaves :

The chlorophyll content of fresh and dried basil leaves was determined by spectrophotometric analysis. The chlorophyll content of fresh basil leaves was found to be 22.92 mg/100g tissue. fluidized bed dryer has chlorophyll 8.41 to 14.46 mg/100g tissue.

Table 3.4.1 : Experimental Results On Chlorophyll Content Of Basil Leaves

Type of dryer	**Temperature (°C)**	**Treatment Unblanched (UB) / blanched (B)**	**Chlorophyll content (mg/100 g of tissue)**	**Loss in chlorophyll content (%)**
Fluidized bed dryer	45	UB	10.19	55.52
		B	14.46	36.92
	55	UB	9.25	59.62
		B	13.75	39.99
	65	UB	8.41	63.31
		B	12.89	43.73

Maximum chlorophyll content (14.46 mg/100g tissue) was found in the blanched sample dried at 45 °C and minimum (8.41 mg/100g tissue) was found in unblanched sample dried at 65 °C. The loss in chlorophyll content compared to fresh sample was in the range of 36.9 to 63.30%, with more losses observed at higher drying temperature. This may be due to the fact that chlorophyll degradation in basil leaves is temperature dependent and followed first order reaction kinetics (Ahmed et al. 2001).

Effect of Drying Conditions on Volatile Oil Content:

Volatile oil content of dried basil leaves is presented in Table 3.5.1. It showed that volatile oil of samples varied from 0.50 to 0.83 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. For example drying of basil leaves at 45, 55 and 65 ^{0}C temperatures, the volatile oil content was found as 0.0.83, 0.0.61 and 0.55 ml/100g d.m., respectively, in the unblanched samples. Whereas, 0.82, 0.60 and 0.50 ml/100g d.m., respectively, in case of blanched samples.. The volatile content of fresh sample was 1.36-ml/100g d.m. 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 3.5.14, it was revealed that volatile loss was minimum (39.71 % d.m. in the blanched samples) at the 45 °C temperature in unblanched samples loss was minimum to 38.98 %.

Table 3.5.1: 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 (%)**
Fluidized bed dryer	45	UB	0.83	38.98
		B	0.82	39.71
	55	UB	0.61	55.13
		B	0.60	55.89
	65	UB	0.55	59.56
		B	0.50	63.24

Effect of Drying Conditions on pH :

pH of the fresh sample of the basil leaves was found 4.86 . Fluidized bed drying pH was decreased for all three temperatures except at 45 °C temperature there was no gain or loss in pH for blanched samples, at 65 °C pH was increased for unblanched samples.

Table 3.6.1 : Experimental results on pH of dried basil leaves**.**

Type of dryer	**Temperature (°C)**	**Treatment Unblanched (UB) / blanched (B)**	**pH of dried leaves**	**Loss /gain in pH (%)**
Fluidized bed dryer	45	UB	4.77	-1.75
		B	4.86	0.00
	55	UB	4.70	-3.19
		B	4.76	-2.06
	65	UB	4.92	+1.34
		B	4.71	-2.98

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 fluidized bed dryer. Fig. 3.7.1 shows a typical chromatogram obtained from a fresh sample from GC-MS analysis and Table 3.7.1 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 3.7.1: 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. Similar results were reported by (Anon.,1966). The area under the chromatographic peaks of the other compounds is small.

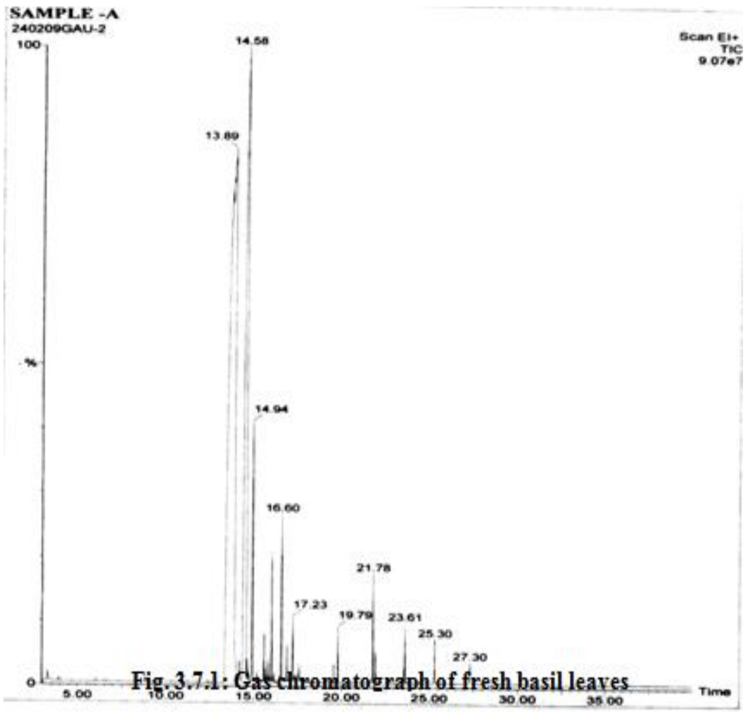


Fig. 3.7.1: Gas chromatograph of fresh basil leaves

Effect of drying conditions on eugenol compound :

Table 3.8.1 shows the eugenol percentage in the dried blanched basil leaves in fluidized bed drying at 45, 55 and 65 °C temperature. In the fresh basil leaves eugenol was 61.69 % and Caryophyllene was 28.77 %.
In the fluidized bed drying blanched basil leaves at 45 °C temperature the eugenol remains almost same as the fresh basil leaves being 61.34%, while at 55 °C temperature, the eugenol was 35.27 % and for 65 °C temperature it was 32.77 %, which shows that the eugenol was affected by the higher temperature and reduced almost half at 55 °C and 65 °C temperatures in the fluidized bed drying.
The eugenol was found highest in fluidized bed drying at 45 °C temperatureand followed by 55 and 65 °C

Table 3.8.1 : 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 (%)**
Fluidized bed dryer	45	B	61.69	61.34
	55	B	61.69	35.27
	65	B	61.69	32.77

Effect Of Drying Conditions On Caryophyllene Compound :

The percentage retentions of the second major volatile compound i.e caryophyllene. in the blanched basil leaves after fluidized bed drying are reported in Table 3.9.1 . It shows that as compared to caryophyllene in the fresh sample of basil leaves it increased in basil leaves dried . This trend was observed similar to trend observed by Mondal (2007).

Table 3.9.1 : 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 (%)**
Fluidized bed dryer	45	B	28.77	28.60
	55	B	28.77	55.62
	65	B	28.77	59.02

Overall Acceptability:

The maximum value of active ingredients (Eugenol and caryophyllene) corresponds to fluidized bed drying at 45°C temperature for blanched sample of basil leaves. The volatile oil, at 45 °C for blanched sample was higher among all the samples. The blanched samples dried at 45 °C in the fluidized bed samples also resulted into maximum chlorophyll

.

Storage Behaviour of Dried Basil Leaves:

The blanched sample dried at 45 °C temperature in fluidized bed dryer resulted into maximum chlorophyll content, volatile oil and eugenol content hence was selected for the storage characteristics to find out biochemical changes and active ingredient during storage period. The effects of storage period on biochemical content and active ingredient are presented in table 3.11.1 & 3.11.2. The eugenol and caryophyllene content were determined by GC and are shown in Fig. 3.11.1.

Table 3.11.1: Biochemical content of dried basil leaves at room temperaturestorage.

Biochemical content	**Storage period (in days)**				
	0	**15**	**30**	**45**	**60**
Chlorophyll,mg/100mg	14.45	14.01	13.45	13.26	12.12
Volatile oil, ml	0.82	0.75	0.65	0.50	0.30
pH	4.86	4.86	4.90	5.01	5.05

Table 3.11.2: Active ingredients content of dried basil leaves at room temperature storage.

Active ingredient	**Storage period (in days)**				
	0	**15**	**30**	**45**	**60**
Eugenol (%)	61.34	61.04	47.31	45.04	27.72
Caryophyllene (%)	28.60	30.72	41.24	44.27	58.43

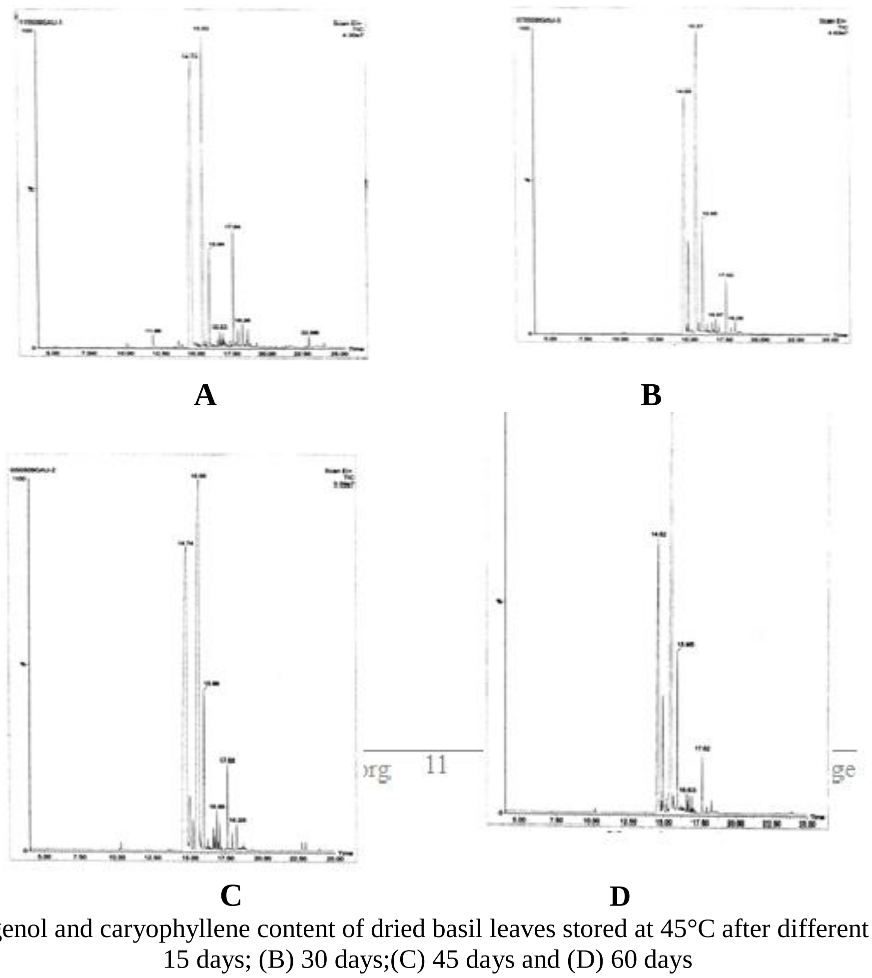


Fig. 3.11.1 Eugenol and caryophyllene content of dried basil leaves stored at 45°C after different intervals: (A) 15 days; (B) 30 days;(C) 45 days and (D) 60 days

Effect Of Storage Time On Biochemical Content:

Table 4.12 showed data on chlorophyll, volatile, pH at 0,15,30,45,and 60 days of storage. It was observed chlorophyll reduced 3.08 % at 15 days, 6.95 % at 30 days, 8.27 % at 45 days and 16.14 % at 60 days, whereas volatile oil loss during the storage was 8.52%, 20.73 %, 39.02% and 0.63 % at 15, 30, 45 and 60 days respectively. It shows that almost more than half volatile oil loss occurred in 60 days. It was also observed that a negligible increase in pH value of dried basil leaves from 4.86 to 5.05 during storage at 60 days.The chlorophyll and volatile oil loss due to its sensitiveness to heat as well as exposer to the oxygen as reported by Rayaguru (2007) and Sablani (2006)

Effect of storage time on active ingredients:

As shown in Table 3.11.2, the eugenol reduced from 61.34. to 27.62 in 60 days storage. It shows that as the storage period increases the eugenol content reduces. Similar was not observed as in case caryophyllene. Caryophyllene increases as the storage period increases.

IV. CONCLUSIONS

The present investigation entitled "Temperature effect on drying and phytochemicals of basil leaves " 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 in the fluidized bed dryer at constant air velocity at 2 m/s at temperature 45, 55 and 65 °C. Unblanched basil leaves were dried as control samples. The effect of drying conditions on chlorophyll content, volatile oil and pH were also investigated. The active ingredients in basil leave viz. eugenol and caryophyllene were also studied. Storage behaviour of the best sample selected having maximum retention of volatile oil content and chlorophyll content in the dried basil leaves was studied for a period of 60 days. 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.
3. Blanched sample took less time for drying compared to unblanched samples in each dryer at every temperature from 45, 55 and 65 °C temperature.
4. Chlorophyll content was found higher in case of blanched samples then unblanched samples of basil leaves.
5. Volatile oil was found slightly less in the blanched samples in comparison to unblanched samples of basil leaves.
6. Volatile oil and chlorophyll content were higher at lower temperature and decreased at higher temperature.
7. Eugenol was found as major active ingredient in the fresh sample of basil leaves, while caryophyllene was the second major active ingredient.
8. In the dried basil leaves, the caryophyllene increased, while eugenol decreased in most of the dryers at higher temperatures.
9. Volatile oil, cholorophyll were decreased during storage and pH slightly increased. Eugenol was decreased, whereas caryophyllene increased during the storage.
10. The product quality in terms of chlorophyll content, volatile oil and pH was found to be most acceptable when basil leaves blanched with steaming at 30 seconds and dried at 45 °C temperature in the fluidized bed dryer.

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International Journal of Engineering Science Invention (IJESI) is UGC approved Journal with Sl. No. 3822, Journal no. 43302.

M. R. Parmar*. "Temperature Effect on Drying And Phytochemicals of Basil Leaves." International Journal of Engineering Science Invention (IJESI), vol. 07, no. 01, 2018, pp. 34–44.