



## Effect of the drying methods on the quality and characterization of green chilli powder

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### Abstract

A study was conducted on "Effect of drying methods on the quality and characterization of green chilli powder". The effect of different methods viz- lyophilize drying, Tray drying and Sun drying and other quality parameter like- physio-chemical and microbial content in green chilli (varieties -*Pusa jwala* and *Jalapeno M*) powder were investigated. By lyophilize drying method best results were observed in terms of Green Colour, higher ascorbic acid (165.20mg/100g) and capsaicin content (0.135 mg/100g) than other drying methods. The capsaicin contents were found in all dried green chilli trials varied from 0.069 to 0.135mg/100g. The characterization of powders was determined by SEM and the shape of particle was observed spherical so it means powders are amorphous form not crystalline. The high microbial count was found in sun dried green chilli. There were significant different in between drying methods and the varieties ( $P \leq 0.05$ ). The green color was found more in *Pusa jwala* variety chilli by lyophilize drying methods and chemical quality attributes was also found significantly in *Pusa jwala* variety of green chilli powder.

**Keywords:** green chilli, drying chilli, quality, SEM

### 1. Introduction

Chilli (*Capsicum annuum*) belongs to the "*Solanaceae*" family. It is rich in vitamins; especially vitamin C <sup>[1]</sup>. Capsicum has synonyms according to their geographical area and region. There are five cultivated species of the genus *Capsicum* *C. frutescens*, *C. chinense*, *C. pubescens*, *C. baccatum* and *Capsicum annuum* but *Capsicum annuum* is the most widely cultivated in all over the India for its characteristics like- non-pungent and pungent <sup>[2]</sup>. It has already proved that, *capsicum annuum*, is the only crop that produces capsaicinoids, which is responsible for the pungency test. Capsaicinoids are alkaloids that are most important in the medical industry for their neurological effectiveness <sup>[3]</sup> etc.

There are many types of dryer instrument used in the domestic and industry sectors. The commonly used dryer are tunnel dryers, tray dryers, fluidized bed drying, drum dryers, spray dryers, rotary dryers, flash dryers, vacuum dryers, freeze dryers (lyophilizer). Currently, hot air drying is more popularly used for drying of chilli due to a relatively short time of drying and also due to uniform heating and more hygienic characteristics. The temperature ranges from 45°C to 70°C (10% of moisture content, approximately), and this will reduce drying time to less than 20 hrs <sup>[4]</sup>. Alsebaei *et al.* <sup>[5]</sup> studied the effect of thermal treatment on the bioactive compounds in green chilli powder, and it found that the bioactive compound higher in variety *Pusa jwala* than *Jalapeno M*, also the lyophilizer drying method was the best followed by tray drying and sun drying. Singh *et al.* <sup>[6]</sup> reported that the lyophilizer dried green chilli was most acceptable in respect of color, flavor, pungency, texture and overall acceptable compared to other dried chilli as sun, tray and vacuum dried and also revealed that *Kashi Anmol* variety

of chilli gave most acceptable in respect to color, pungency, flavor and texture followed by variety (*Pusa sadabahar*). The aim of this research was to determine the effect of the drying method in the quality (physical and chemical properties) of Green Chilli powder.

### 2. Materials and methods

The samples of green chilli were procured from local market of Varanasi, India. The experiments were conducted at Centre of Food Science and Technology, Institute of Agricultural Sciences; Department of Pharmacy, Indian Institute of technology; Department of Botany, Faculty of Sciences; at Banaras Hindu University, Varanasi (UP), India.

#### 2.1 Processing of Green Chilli Powder

The method of fresh green chilli powder is show in Fig 1.

#### 2.2 Physical Analysis of Green Chilli Powders

Surface color measurement was conducted using the (L, a, b) <sup>[1]</sup> system (Hunter Lab). Bulk density was determined according to protocol of Sahin-Nadeem *et al.*, <sup>[7]</sup> and Tapped density was determined according to Ozdikiçierler *et al.* <sup>[8]</sup>. The flowability of the powders was evaluated in terms of the Carr index (CI) <sup>[9]</sup>. CI was calculated from the bulk and tapped densities as Eq. (1):

$$CI = \frac{\text{Tapped Density} - \text{Bulk Density}}{\text{Tapped density}} \times 100 \quad (1)$$

<sup>1</sup> L\* lightness, a\* greenness and b\* yellowness

### 2.3 Chemical Analysis of Green Chilli Powders

Chemical analysis moisture, crude fat, crude proteins, ash and Vitamin C contents were analyzed by the method of AOAC, [10]. Reducing sugar was estimated by Lane and Eynon's

method reported by Ranganna, [11]. Capsaicin content was determined by using high performance liquid chromatography (HPLC) according to Betts, [12].

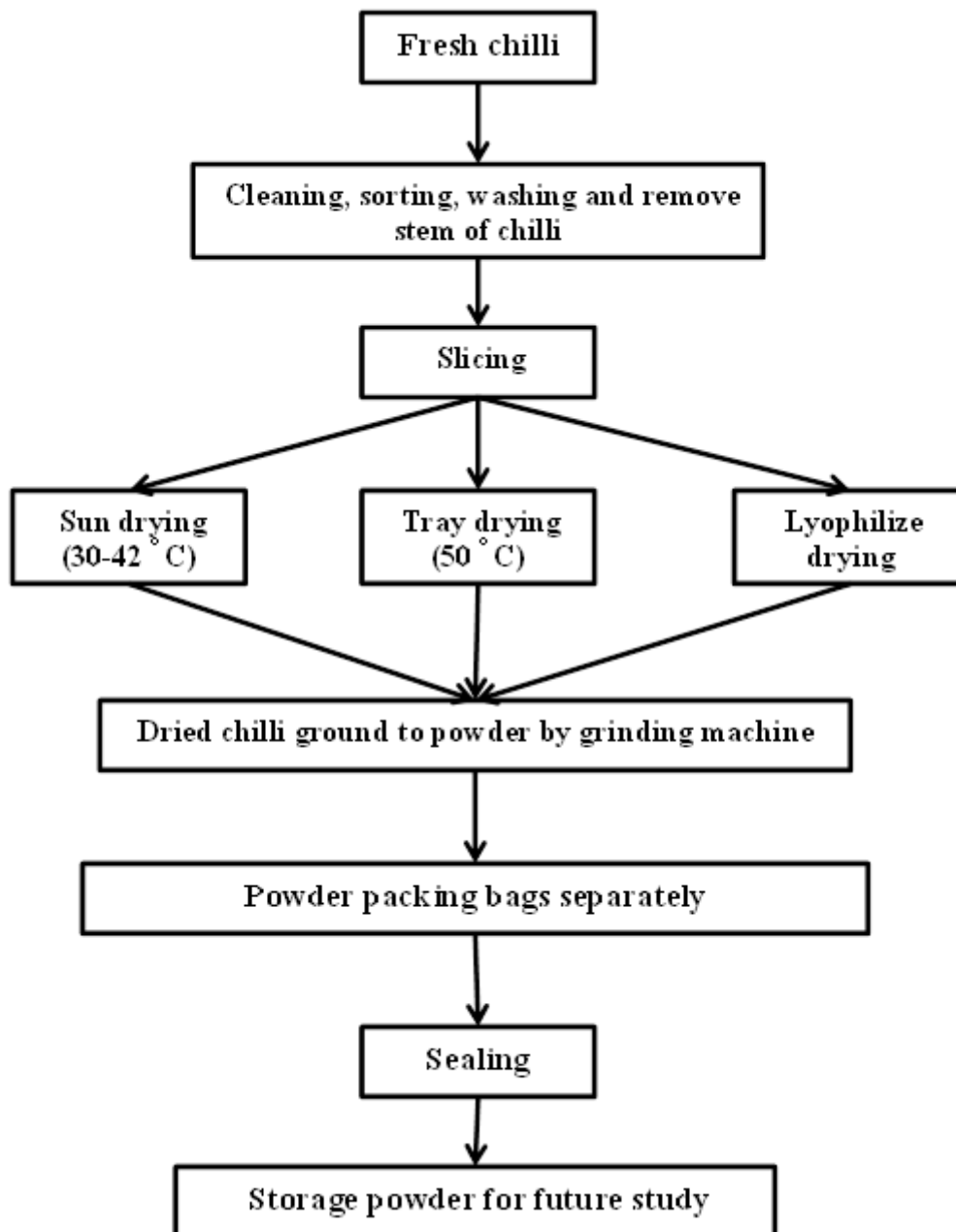


Fig 1: Flow diagram for processing of green chilli powder

### 2.4 Microscopy characterizations of green chilli powders

A small quantity of green chilli powders (180–250 µm) from different drying methods were mounted on aluminum stubs and coated with a fine layer of gold (15 nm) using a Sputter gold coater. All powder samples were examined by Scanning Electron Microscopy using SEM Hitachi S-570 camera operated at an accelerating voltage of 20 kV [13].

### 2.5 Microbiological Analysis of Green Chilli Powders

The green chilli powders were analyzed for total plate count,

yeast and mold count and coliform count using plate count agar (PCA), potato dextrose agar (PDA) after incubation at 25°C for 48 hrs and violet red bile agar (VRBA) after incubation at 37°C for 24 hrs [10].

### 2.6 Sensory evaluation

The overall acceptability (Colour, Flavour, Pungency) of the green chilli powders were evaluated by a panel of 15 experienced taste panelists described by Tummala *et al.*, [18]. The scores were noted over a hedonic scale with a maximum

score of 9 for “like extremely” and minimum of 1 for “dislike extremely”. The hedonic rating test in a scale of 1-9 marking was given as follows: dislike extremely (1), dislike very much (2), dislike moderately (3), dislike slightly (4), neither like nor dislike (5), like slightly (6), like moderately (7), like very much (8), like extremely (9).

## 2.7 Statistical Analysis

Means of the triplicate values and standard deviations from the obtained data were calculated and statistically analyzed using SAS version 9.1. Meanwhile, Duncan’s multiple range tests was applied to determine the differences in the different among the samples.

## 3. Results & Discussion

### 3.1 Composition of Fresh Green Chilli

The fresh green chilli was analyzed for moisture, protein, fat, ash, capsaicin and vitamin C and these results are presented in Table 1. The fresh green chilli *Pusa Jwala* variety contained 87.37% moisture, 5.83 % protein, 1.77 % fat, 0.824 % ash, 112.27 mg/100g vitamin C, 3.2667% fiber, 6.15% reducing sugar and capsicum 0.037 mg/100 g. while *Jalapeno M* variety contained 85.69% moisture, 4.77% protein, 1.10 % fat, 1.08 % ash, 2.53% fiber, 5.22% reducing sugar, 106.20 mg/100g vitamin C, and capsicum 0.034mg/100g. The protein, fat, fiber, reducing sugar and vitamin C of dried chilli were significantly different among the varieties ( $P \leq 0.05$ ), but moisture, ash and capsicum were not significantly similar among the varieties ( $P \leq 0.05$ ).

**Table 1:** Chemical analysis of fresh green chilli

Compounds	Varieties	
	<i>Pusa Jwala</i>	<i>Jalapeno M</i>
Moisture (%)	85.69±0.74 <sup>a</sup>	87.37±1.09 <sup>a</sup>
Ash (%)	0.824±0.12 <sup>a</sup>	1.08±0.12 <sup>a</sup>
Reducing sugar (mg)/ g	1.77±0.02 <sup>a</sup>	1.01±0.020 <sup>b</sup>
Protein (%)	5.83±0.21 <sup>a</sup>	4.77±0.15 <sup>b</sup>
Fiber (%)	3.27±0.12 <sup>a</sup>	2.53±0.15 <sup>b</sup>
Fat (%)	6.15±0.33 <sup>a</sup>	5.22±0.21 <sup>b</sup>
Ascorbic acid mg/100g	112.27±0.35 <sup>a</sup>	106.20±0.27 <sup>b</sup>
Total Phenol Count (mg/100gm)	13.25±0.50 <sup>a</sup>	10.30±0.52 <sup>b</sup>

\*\* Each value is Mean ± Standard Deviations (n = 3).

Different superscripts in rows are significantly different (P < 0.05).

The overall results of proximate chemical composition of fresh green chilli 85.5% moisture, 5.4 % protein, 1.1 % fat, 1.2 % mineral, 110 mg per % of vitamin C similar reported by Srivastava *et al.*<sup>[14]</sup>. The slight variation were observed due to varietal difference, soil property, growing condition, harvesting period, maturity stage, agro-ecological condition

and methods of analysis.

### 3.2 Effect of drying methods on colour

The effect of drying methods on the colour of the green chilli powder was presented in Table 2. The colour was measured by hunter lab by presenting the L, a, b values. The values of L, a, b, were range from L 40.23 to 50.68, a-8.01 to -1.67 and b16.34 to 18.47.

All the values were Compared with the fresh green chilli resulted from L= 37.04, a= -9.46 and b=18.69 in the *Pusa jwala* variety of chilli, while L, a, b values of *Jalapeno M* variety of chilli was observed from 45.45 to 59.45, -1.03 to -0.86 and 17.34 to 20.34 in comparison of fresh chilli L= 46.98, a= -0.36 and b=19.52. Lyophilize drying method was found more significantly than other drying methods. The green colour was retaining due to low temperature by Lyophilizer drying process. The finding was similar with agreement of Sing *et al.*,<sup>[6]</sup>.

**Table 2:** Effect of drying method on the color of green chilli powder

Treatment		Varieties	
		<i>Pusa jwala</i>	<i>Jalapeno M</i>
Raw Green chilli	L	40.23±0.94 <sup>a</sup>	45.45±0.94 <sup>b</sup>
	a	-8.01±0.06 <sup>a</sup>	-1.03±0.02 <sup>b</sup>
	b	17.45±0.53 <sup>a</sup>	13.87±0.08 <sup>b</sup>
LGCP	L	45.05±0.85 <sup>a</sup>	54.65±0.85 <sup>b</sup>
	a	-4.30±0.12 <sup>a</sup>	0.23±0.01 <sup>b</sup>
	b	16.34±0.32 <sup>a</sup>	16.34±0.04 <sup>a</sup>
TGCP	L	50.68±0.17 <sup>a</sup>	59.45±0.63 <sup>b</sup>
	a	-1.67±0.03 <sup>a</sup>	0.86±0.01 <sup>a</sup>
	b	18.74±0.32 <sup>a</sup>	12.34±0.02 <sup>b</sup>
SGCP	L	40.23±0.94 <sup>a</sup>	45.45±0.94 <sup>b</sup>
	a	-8.01±0.06 <sup>a</sup>	-1.03±0.02 <sup>b</sup>
	b	17.45±0.53 <sup>a</sup>	13.87±0.08 <sup>b</sup>

\* Each value is Mean ± Standard Deviations (n = 3).

Different superscripts in rows are significantly different (P < 0.05).

LGCP: Lyophilize green chilli powder, TGCP: Tray green chilli powder and SGCP: Sun green chilli powder

### 3.3 Effect of drying methods on the physical properties

The physical quality parameter of green chilli powders of *Pusa jwala* and *Jalapeno M* were analyzed for bulk density and tapping density, the results were presented in Table 4. There was significant ( $P \leq 0.05$ ) difference between Lyophilize green chilli powder in comparison to bulk and tap density. The Flowability of green chilli powder present in Table 6. According to Jinapong *et al.*<sup>[9]</sup>, if the Carr index ranges from 26 to 31, the flowability will be poor. Poor result was showed due to the humidity of the air around the powder, the equipment the powder is flowing through and pressure applied to the powder.

**Table 3:** Physical analysis of green chilli powders

Samples	Components			
	Bulk Density		Tapping Density	
	<i>Pusa jwala</i>	<i>Jalapeno M</i>	<i>Pusa jwala</i>	<i>Jalapeno M</i>
LGCP	0.50±0.006 <sup>Aa</sup>	0.51 ±0.003 <sup>Aa</sup>	0.68±0.009 <sup>Aa</sup>	0.68±0.009 <sup>Aa</sup>
TGCP	0.49 ±0.004 <sup>Ba</sup>	0.50 ±0.004 <sup>Ba</sup>	0.67 ±0.005 <sup>Aa</sup>	0.68 ±0.005 <sup>Ab</sup>
SGCP	0.48 ±0.003 <sup>Ba</sup>	0.49 ±0.003 <sup>Bb</sup>	0.65 ±0.008 <sup>Ba</sup>	0.65±0.005 <sup>Ba</sup>

\* Each value is Mean ± Standard Deviations (n = 3).

Different superscripts (small letter) in rows are significantly different (P < 0.05).

Different superscripts (capital letter) in columns are significantly different (P < 0.05).

**Table 4:** Flow ability of green chilli powder according to Carr Index

Sample	Components			
	Carr Index		Flow ability	
	<i>Pusa jwala</i>	<i>Jalapeno M</i>	<i>Pusa jwala</i>	<i>Jalapeno M</i>
LGCP	26.02±0.26 <sup>Aa</sup>	25.01±0.67 <sup>Aa</sup>	Poor	Poor
TGCP	27.50±0.90 <sup>Bb</sup>	27.39 ±0.37 <sup>Ba</sup>	Poor	Poor
SGCP	27.50±0.12 <sup>Aa</sup>	25.08±0.51 <sup>Aa</sup>	Poor	Poor

\* Each value is Mean ± Standard Deviations (n = 3).

Different superscripts (small letter) in rows are significantly different (P < 0.05).

Different superscripts (capital letter) in columns are significantly different (P < 0.05).

### 3.4 Effect of drying methods on chemical composition

The quality of green chilli powders were depended on the methods drying processing viz- Lyophilize, Tray and Sun. The chemical parameter like- moisture, ash, protein, fat and vitamin C were analyzed. The results are presented in Table 5. The moisture was found in all dried green chilli range from

7.34- 9.53%. The results were agreement with reported by Krishnamurthy and Natarajan, [16]. The ash content of green chilli powders were significantly different among all the samples (P≤0.05). The finding was agreed with Raina and Teotia [17] who found that it was ranged from 4.53 to 7.39 %.

The protein content was also found significantly different among the samples (P≤0.05). The results were presented varied from 14.60 and 16.85%. It was noticed that protein was also reported 15.4% in dry chilli per 100 g within range to our findings Srivastava *et al.* (1994).

The fat content of green chilli powder were found moreless similar to reported (6.2%) by Srivastava *et al.*, [14].

The ascorbic acid contents of all of dried green chilli found significantly different among the samples (P≤0.05). The ascorbic acid contents of all dried green chilli varied between 70.57 and 165.20 mg/100 g. The variations were due to difference in treatments, preparation and drying methods applied.

**Table 5:** Chemical analysis of green chilli powder

Samples	Components					
	Moisture %		Ash%		Protein %	
	<i>Pusa jwala</i>	<i>Jalapeno M</i>	<i>Pusa jwala</i>	<i>Jalapeno M</i>	<i>Pusa jwala</i>	<i>Jalapeno M</i>
LGCP	8.99±0.08 <sup>Aa</sup>	9.53±0.68 <sup>Aa</sup>	6.80±0.16 <sup>Aa</sup>	7.18±0.18 <sup>Aa</sup>	16.87±0.21 <sup>Aa</sup>	15.67 ±0.25 <sup>Ab</sup>
TGCP	7.34 ±0.11 <sup>Ba</sup>	7.54±0.21 <sup>Ba</sup>	7.37±0.72 <sup>Ba</sup>	7.78±0.25 <sup>Ba</sup>	15.17±0.06 <sup>Ba</sup>	14.73 ±0.15 <sup>Bb</sup>
SGCP	8.23±0.20 <sup>Ca</sup>	8.52±0.71 <sup>Ca</sup>	9.01±0.25 <sup>Ca</sup>	9.34±0.21 <sup>Ca</sup>	15.10 ±0.27 <sup>Ca</sup>	14.60±0.10 <sup>Cb</sup>

\* Each value is Mean ± Standard Deviations (n = 3).

Different superscripts (small letter) in rows are significantly different (P < 0.05).

Different superscripts (capital letter) in columns are significantly different (P < 0.05).

**Table 5:** (Continuous)

Samples	Components					
	Crude fat %		Reducing sugar mg/ g		Ascorbic acid mg / 100 g	
	<i>Pusa jwala</i>	<i>Jalapeno M</i>	<i>Pusa jwala</i>	<i>Jalapeno M</i>	<i>Pusa jwala</i>	<i>Jalapeno M</i>
LGCP	5.23 ±0.15 <sup>Aa</sup>	5.76 ±0.61 <sup>Ab</sup>	80.62±0.33 <sup>Aa</sup>	79.48±0.12 <sup>Ab</sup>	165.20±0.200 <sup>Ab</sup>	156.30±0.400 <sup>Aa</sup>
TGCP	5.00 ± 0.06 <sup>Aa</sup>	5.57±0.63 <sup>Ab</sup>	81.19±0.32 <sup>Aa</sup>	79.98±0.33 <sup>Ab</sup>	130.50±0.100 <sup>Bb</sup>	111.80±0.600 <sup>Ba</sup>
SGCP	4.83 ±0.25 <sup>Aa</sup>	5.33 ±0.30 <sup>Ab</sup>	96.80±0.32 <sup>Ba</sup>	93.51±0.77 <sup>Bb</sup>	90.70±0.300 <sup>Cb</sup>	70.57±0.493 <sup>Ca</sup>

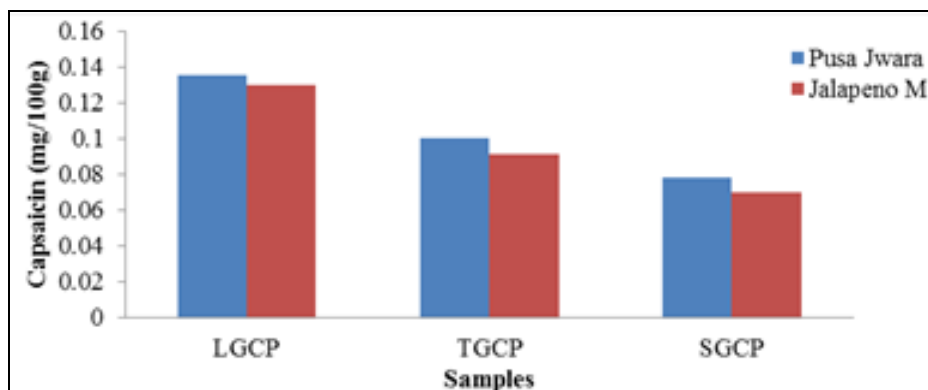
\* Each value is Mean ± Standard Deviations (n = 3).

Different superscripts (small letter) in rows are significantly different (P < 0.05).

Different superscripts (capital letter) in columns are significantly different (P < 0.05).

The capsaicin content in green chilli powders present in figure (2). It was observed that there was no effect of drying on the capsaicin content. The capsaicin content was higher in all the dried samples in comparison to fresh chilli sample. The

capsaicin content of all dried chilli varied between 0.070 and 0.135mg/100g (P>0.05). Finding results were agreed with Toontom *et al.* [18] who reported that capsaicin content of all dried chilli varied between 0.09 and 0.1 mg/100g.

**Fig 2:** Capsaicin content on green chilli powders using different drying methods

### 3.5 Morphological Characterization of green chilli powders by SEM

The morphology of green chilli powders was studied by SEM. The SEM pictures of typical pulverized particle are shown in Fig. 3. It was observed that the morphology of practical of was smaller. The result was showed that, the dried green chilli was crushed into very small pieces, it was destroyed in the

amorphous region. There were some small crystals in the particle. The dried green chilli was broken by the strong mechanical impact of the grinding equipment, and the edge of the particle was rounded. Also the shape of particle was observed spherical so it means powders are amorphous form not crystalline.

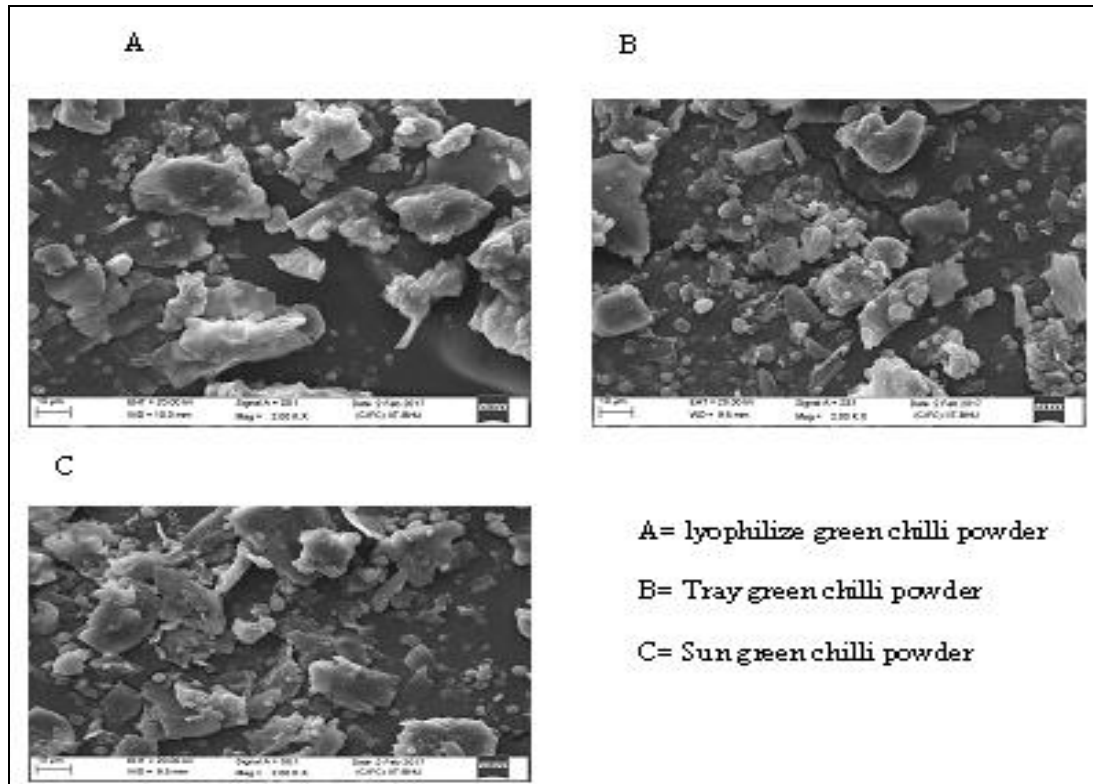


Fig 3: Scanning Electron Micrographs of green chilli powders

### 3.6 Effect of Drying Methods on the Microbiological Counts

On the microbial study of the green chilli powders of *Pusa jwala* and *Jalapeno M* varieties, the total microbial, *E. coli*,

yeasts and mold content were analyzed and results were presented in table 6. The total microbial count was higher in the all sample of *Jalapeno M* variety by all the drying process in comparison to others varieties.

Table 6: Total microbial count in green chilli powder

Testing	Varieties	Sample		
		LGCP	TGCP	SGCP
TPC	<i>Pusa jwala</i>	1.88±0.64 <sup>a</sup>	2.73±0.05 <sup>a</sup>	2.95±0.2 <sup>a</sup>
	<i>Jalapeno M</i>	1.90±0.13 <sup>a</sup>	2.93±0.07 <sup>a</sup>	3.06±0.06 <sup>a</sup>
<i>E. coli</i>	<i>Pusa jwala</i>	ND	ND	ND
	<i>Jalapeno M</i>	ND	ND	ND
Yeast and Mold	<i>Pusa jwala</i>	ND	ND	0.96±0.08
	<i>Jalapeno M</i>	ND	ND	1.00±0.21

ND= Not Detected

Each value is Mean ± Standard Deviations (n = 3).

Different superscripts in row are significantly different (P < 0.05).

### 3.7 Sensory evaluation of green chilli powder

The sensory attributes like color, pungency, flavor and overall acceptability of the green chilli powders of varieties of *Pusa jwala* and *Jalapeno M* were evaluated by the panel of 10 judges. The samples subjected to sensory evaluation included

sun, tray, vacuum and lyophilize green chilli powders of varieties of *Pusa jwala* and *Jalapeno M*. The panelists were evaluated by making Chutney from green chilli powder of both the varieties. The score was tabulated in Table 7.

**Table 7:** sensory score of green chilli powder

parameters	Varieties	Samples		
		LGCP	TGCP	SGCP
Colour	<i>Pusa jwala</i>	8.33±0.32 <sup>Aa</sup>	7.53±0.12 <sup>Ab</sup>	7.20±0.21 <sup>Ab</sup>
	<i>Jalapeno M</i>	6.03±0.08 <sup>Ba</sup>	5.30±0.75 <sup>Bb</sup>	5.00±0.32 <sup>Bb</sup>
Flavor	<i>Pusa jwala</i>	8.40±0.12 <sup>Aa</sup>	7.87±0.42 <sup>Ab</sup>	7.27±0.12 <sup>Ab</sup>
	<i>Jalapeno M</i>	7.33±0.15 <sup>Ba</sup>	6.60±0.46 <sup>Bb</sup>	5.53±0.52 <sup>cc</sup>
Taste/ Pungency	<i>Pusa jwala</i>	7.60±0.17 <sup>Aa</sup>	6.87±0.39 <sup>Ab</sup>	6.07±0.14 <sup>cAc</sup>
	<i>Jalapeno M</i>	7.40±0.23 <sup>Aa</sup>	6.07±0.17 <sup>Ab</sup>	6.01±0.17 <sup>cAc</sup>
overall acceptability	<i>Pusa jwala</i>	8.80±0.07 <sup>Aa</sup>	7.67±0.14 <sup>Ab</sup>	7.20±0.34 <sup>Ac</sup>
	<i>Jalapeno M</i>	8.33±0.05 <sup>Aa</sup>	7.33±0.18 <sup>Ab</sup>	6.20±0.42 <sup>Bc</sup>

Each value is Mean ± Standard Deviations (n = 15).

Different superscripts (small letter) in rows are significantly different ( $P < 0.05$ ).

Different superscripts (capital letter) in columns are significantly different ( $P < 0.05$ ).

#### 4. Conclusion

The present study was undertaken using different drying processing methods. Lyophilize drying process gave more green colour contained higher ascorbic acid (165.20 mg/100g). The capsaicin (0.135 mg/100g) was found more by lyophilize drying process rather than the other drying process like tray and sun drying methods. The green colour was slightly differ from lyophilize drying comparable to tray drying. Also the shape of particle was observed spherical so it means powders are amorphous.

#### 5. Acknowledgments

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