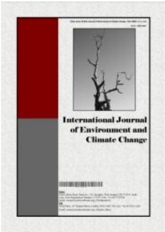

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Effect of Different Drying Methods on Physico-Chemical Attributes of Guava's Fruit Pulp Powder

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Guava (*Psidium guajava L.)* is one of the most popular fruits in tropical and subtropical regions of India. It is popularly known as" Apple of tropics", belongs to the family Myrtaceae and often considered as "super fruit". It is rich in vitamin A and C, omega-3 and 6 polyunsaturated fatty acids and contains high levels of dietary fiber and other nutritional properties. Guava is a highly perishable fruit crop and has a very limited shelf life, so there is a need to preserve the fruits in dried form, whose powder can be used for processing purposes, value addition in off season demands. Therefore, we conducted an experiment to study the effect of different drying methods on physico-chemical attributes of guava's fruit pulp powder (Santos et al., 2017). Fruits of guava pulp were used to prepare powder by different drying methods like freeze drying, sun drying, air drying and oven drying. Results showed that bulk density and moisture percent was highest recorded in sun drying method followed by air drying while minimum was recorded with oven drying followed by freeze drying. Maximum nutritional value likeFiber (5.97%), Ash(1.38%), Protein percent (1.82%), Total sugar (32.88%), reducing (23.14%) & non-reducing sugar (9.73%), ascorbic acid (227.90 mg/100 g), Titratable acidity (2.20%), Total phenols (250.66) and DPPH radical scavenging activity (83.40) was observed maximum with freeze drying followed by air drying. Taste, flavour, aroma and overall acceptability were better in freeze drying followed by Air drying.

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Keywords: Guava; DPPH; vitamin–C; total phenols; pulp powder; drying methods.

1. INTRODUCTION

The guava (*Psidium guajava* L.) is one of the most important commercial fruit crops in India and belong to the family Myrtaceace. It is believed to be native in central America and the southern part of Mexico [1]. Guava fruit is considered as a highly nutritious fruit because it contains a high level of ascorbic acid (200-299 mg/100g of fresh weight), which is five to six time higher than oranges. Guava is a very popular fruit for their easy adaptability in diverse agro-climatic condition. It is available throughout the year except during the summer season. Therefore, "it is commonly referred to as 'Poor man's Apple' and Apple of the Tropics'. In india, it ranks fourth in total cultivated area after mango, banana, and citrus. Uttar Pradesh is the largest producer of guava in india and Allahabad has the reputation of producing the world's best guavas" [2].

"It is also an excellent source of beta carotene, lycopene, calcium, potassium, zinc, and Soluble fiber. Guavas are very rich in antioxidants which can acts against the free radicals that damage cells and cause cancer, diabetes, and coronary disease" (Kuldeep et al., 2019). "Guava can be consumed fresh or can be processed form like jelly, jam, juice, nectar, pulpand slices in syrup, fruit bar or dehydrated products, as well as being used as an additive to other fruit juices and pulp" [3].

"The major objective of drying is to preserve the fruits, it also lowers the cost of transportation and storage by reducing both weight and volume of final product. Freeze drying, is the best drying technique to produce highest quality food products in terms of appearance and retention of nutrient and sensory characteristics" [4].

Being perishable in nature, guava fruits had a very limited shelf life so there is need to preserve the fruits in dehydrated form. Therefore, the prime objective of this work was to undertaken effect of different drying methods on physico-chemical attributes of Guava's fruit pulp powder. And sencond objective was to study effect on storage of these drying method methods such as freeze drying, sun drying, air drying and oven drying and their effect on storage [5-7].

2. MATERIALS AND METHODS

2.1 Location of Experiment

Experiment was conducted in the University Laboratory, RVSKVV, Gwalior, MP, India during the period of February 2022 to March, 2022.

2.2 Collection of Fruit Samples

Fully mature fruits were collected from the guava Orchard, they were thoroughly washed under tap water to remove dust & impurities and segments were cut and separated from the seed with the help of knife.

2.3 Drying Methods and Preparation of Fruit Pulp Powder

In Gwalior during February, it was mild cold sunny days when the fruits were dried under sun, for Sun drying fruit pulp was dried under the sun for five to six days. In Oven Drying the pulp was kept in the hot air oven at 55°C and for Air drying, pulp pieces were kept under air circulated incubator at constant 25°C until the moisture is reduced to minimum 10%. For freeze drying, fruit pulp segments were kept at -40°C for 5 hours and the freeze dried at -50°C and 52 pa pressure for 22 hours. The dried pieces were grinded to fine powder and filtered using muslin cloth. The powder was kept under plastic sealed bags and stored at 4°C until the analysis [8].

2.4 Physico-Chemical Analysis

2.4.1 Moisture, bulk density, total soluble solids, and pH

"The moisture content was determined by drying at 70°C up to constant weight and expressed in terms of the percent wet basis (100X kg water/kg wet material).Bulk density of powder was obtained by measuring the volume of a determined weight of the powder in a 100 ml graduated glass cylinder. The ratio of mass of the powder and the volume occupied in the cylinder determines the bulk density value (g/cm3)" [9]. Total soluble solids (TSS) (°Brix) of the juice of fresh pulp was determined by using hand refractometer and pH of pulp juice was determined by digital pH meter.

2.4.2 Ascorbic acid, titratable acidity

Ascorbic acid (Vitamin-C) content of the sample was analyzed by using 2, 6- dichlorophenol indophenol dye method as described by Ranganna [10]. And expressed in mg per 100 g.

Titratable acidity (%) of guava powder samples was measured by AOAC, [11] method by boiling the sample for 1 h in water and making up the volume up to 100 ml and then titrating it against 0.1 N sodium hydroxide solution using phenolphthalein indicator.

2.4.3 Ash, Fiber and protein

Protein was estimated as per the method described by Lowry, et al. [12].

2.4.4 Total sugar, reducing sugar and non-reducing sugar

Total sugar and reducing sugar content were measured using methods of Lane and Eynon as described byRanganna. Non-reducing sugar was estimated by subtracting reducing sugar from total sugar.

2.4.5 Total phenols and DPPH radical scavenging activity

The 10 g powder sample was homogenized along with 40 ml of methanol at a magnetic stirrer at 300 rpm, supernatant was increased by adding 50 ml methanol, and this extract was reduced in the volume by rotary vacuum evaporator. The concentrated solution was filtered through filter paper and was stored in plastic bottles at 4°C until analyzed. This extract was used to determine phenols and antioxidant activity.

Total phenolic content (TPC) in fresh or freeze-dried guava samples was determined by the Folin-Ciocalteu method [13]. The TPC was expressed as mg gallic acid equivalent (mg GAE/g) from the standard curve prepared by using pure gallic acid.

Free radical scavenging activity of extracts was measured by the slightly modified method of Alothman et al., [14]. The antioxidant capacity of the fruit extracts was studied through the evaluation of the free radical- scavenging effect on the 1, 1-diphenyl-2-picrylhydrazyl (DPPH) radical. An aliquot (100 µl) of fruit extract was mixed with 3.9 ml of 0.1 mM DPPH methanolic solution. The mixture was thoroughly vortex-mixed and kept in the dark for 30 min. The absorbance was measured later, at 517 nm, against a blank of methanol and ascorbic acid as standard. Results were expressed as percentage of inhibition of the DPPH radical.

2.5 Sensory Analysis

Sensory analysis of samples was done at 9.0-point hedonic scale. Ten semi trained panelists aged between 21 and 45 years, were selected to take part in the sensory panel. The panel measured the taste, flavor, aroma and overall acceptability.

2.6 Statistical Analysis

The data were obtained in triplicates (n=3) for each parameter and their mean was calculated. Data significantly was analyzedstatistically using one-way ANOVA. F-test was adopted forthe level of significance at 5%. Standard error of difference(SEd) and Critical difference (CD) were also obtained.

3. RESULTS AND DISCUSSION

3.1 Physico-Chemical Attributes of Fresh Guava's Fruit Pulp

The data represented in (Table 1) showing the Physico-Chemical Attributes of Fresh Fruit of Guava Pulp that were used for preparation of dried guava powder. Analysis revealed that the moisture content of fresh guava fruit is (85.83%) is reported and Bulk density (0.97 g/cm3). The chemical analyses of the fresh fruit revealed that it contains pH, TSS (Total Soluble Solids) and titratable acidity was found 5.01, 11.04°Brix and 0.585% respectively. Guava having also a good amount of dietry fiber (2.88%), protein (0.50%), ash (0.66%), total sugar (10.85%), reducing sugar (7.64%), non-reducing sugar (3.21%) and ascorbic acid (280.66 mg/100 g).

3.2 Physico-chemical Attributes of Guava's Fruit Pulp Powder

3.2.1 Moisture and bulk density

The drying methods showed significant results, highest moisture content (6.73%) was found in sun drying followed by air drying (6.26%) methods (Table 2). Because drying under uncontrolled environments which cause more

Table 1. Physico-chemical attributes of fresh guava's fruit pulp

S.No.	Parameters	Mean ± SD*
1.	Weight of pulp per fruit (g)	111.6± 3.51
2.	Volume of pulp per fruit(cm3)	114.46±1.24
3.	Bulk density(g/cm3)	0.97±0.021
4.	Moisture%	85.83±0.40
5.	pH	5.01±0.68
6.	TSS(Total Soluble Solids)°Brix	11.04±0.26
7.	Titratable acidity%	0.58±0.04
8.	Dietry fiber%	2.88±0.35
9.	Protein%	0.50±0.05
10.	Ash%	0.66±0.02
11.	Total sugar%	10.85±0.53
12.	Reducing sugar%	7.64±0.43
13.	Non-reducing sugar%	3.21±0.19
14.	Ascorbic acid(mg/100g)	280.66±16.01

Data presented in Mean± Standard Deviation

Table 2. Effect of drying methods on physico-chemical attributes and proximate of guava's fruit pulp powder (plotted values in average)

S.No.	Drying methods	Parameters						
		Moisture %	Weight of powder per fruit (g)	Volume of powder per fruit (cm3)	Bulk density (g/cm3)	Ash %	Fiber%	Protein %
1.	Sun drying	6.73	41.56	54.2	0.76	1.04	4.52	0.75
2.	Oven drying	3.85	17.52	36.17	0.48	1.14	4.94	0.94
3.	Air drying	6.26	31.56	46.67	0.67	1.27	5.53	1.06
4.	Freeze drying	4.17	24.86	42.94	0.57	1.38	5.97	1.82
	SEd±	0.15	0.84	1.40	0.02	0.01	0.51	0.08
	C.D.(P=.05)	0.35	1.95	3.23	0.06	0.04	1.19	0.20

chances of environmental affect. Bulk density was reported highest in sun drying (0.76) followed by air drying (0.67) and both methods differed significantly. More moisture tends to put more bulk density .While oven drying possessed minimum moisture percent and bulk density because of temperature is higher than other methods and environmental condition is controlled.

3.2.2 Ash, fiber and protein

Ash, fiber and protein content were significantly differed among different drying methods. However, oven drying and air-drying methods were found at par with each other. Significantly highest content of ash (1.38), fiber (5.97) and protein (1.82) were found in pulp powder when freeze dried followed by air dried. The minimum content was found with sun drying method (Table 2). As opposed to sun drying, which is influenced by environmental fluctuation, and oven drying, where temperature is high and more component degradation occurs, freeze drying and air-drying methods are characterised by low temperature treatment under controlled conditions that eliminates environmental fluctuation and results in minimal component degradation, such as ash, fibre and protein. Results are in accordance with the reports of [15-18,8], they reported freeze drying method as best as compared to other methods like oven drying, sun drying etc.

3.2.3 Titratable acidity, total sugar, reducing and non-reducing sugar

Significant results were obtained. The maximum titratable acidity (2.20), total sugar (32.88), reducing sugar (23.14) and non-reducing (9.73) were found with freeze drying method followed by air drying (Table 3). Minimum titratable acidity (1.38) was reported with oven drying method while minimum total sugar (22.79), reducing sugar (16.04) and non-reducing sugar (6.74) content was reported under sun drying method. Oven drying and air drying methods were at par with each other.Reduced sugar content and acidity results from browning of sugars during sun drying and oven drying under the influence of heat. As opposed to freeze drying, which keeps a high sugar content while considerably reducing the likelihood of browning.

3.2.4 Ascorbic acid, total phenols and DPPH radical scavenging activity

Data analysis revealed highly significant results, the highest recovery of ascorbic acid was reported with freeze drying (227.90) followed by air drying (204.11) and oven drying (143.15) respectively, while minimum was reported with sun drying (122.97). The maximum total phenol content was reported with freeze drying (250.66) followed by air drying (207.9), while minimum was reported under oven drying (162.42) method. Highest inhibition of DPPH radical was observed under freeze drying method (83.40), succeeding air drying method (69.57) (Table 4). Ascorbic acid and phenols are less likely to be retained during sun drying because of increased oxidation and breakdown, whereas oven drying uses high heat and also results in decreased retention of these chemicals. Ascorbic acid is a delicate substance that greatly decreases after heat treatment, as well as when exposed to sunlight and other environmental changes. The issues of oxidation, high temperatures, and environmental effects are practically all eliminated by freeze drying and air drying, while low temperatures enable improved ascorbic acid and phenol retention [19,2,4,20,14,10]. According to studies [21,18,13], the presence of phenols, ascorbic acid, and other bioactive substances has a direct correlation with antioxidant activity. More antioxidant activity may be due to the greater ascorbic acid and phenolic content discovered during freeze drying and air drying (DPPH Radical Scavenging Activity [22-24].

Table 3. Effect of drying methods on Titratable acidity, total sugar, reducing and non reducing sugars of guava fruit pulp powder

S.No.	Drying methods	Parameters			
		Titratable acidity%	Total Sugar%	ReducingSugar%	Non- Reducing Sugar%
1.	Sun drying	1.64	22.79	16.04	6.74
2.	Oven drying	1.38	26.80	18.87	7.93
3.	Air drying	1.92	30.17	21.23	8.93
4.	Freeze drying	2.20	32.88	23.14	9.73
	SEd±	0.08	1.13	0.93	0.41
	C.D.(P=.05)	0.18	2.62	2.15	0.96

Table 4. Effect of drying methods on ascorbic acid, total phenols and DPPH radical scavenging activity of guava fruit pulp powder

S.No.	Drying methods	Parameters		
		Ascorbic acid (mg/100 g)	Total phenols (mg/100 g GAE)	DPPH radical scavenging activity%
1.	Sun drying	122.97	188.92	54.86
2.	Oven drying	143.15	162.42	48.04
3.	Air drying	204.11	207.9	69.57
4.	Freeze drying	227.90	250.66	83.40
	SEd±	6.72	1.62	0.61
	C.D.(P=.05)	15.51	3.74	1.42

Table 5. Effect of drying methods on sensory aspects of guava's fruit pulp powder

S.No.	Drying methods	Parameters			
		Taste	Flavour	Aroma	Overall acceptability
1.	Sun drying	6.43	6.75	7.09	6.56
2.	Oven drying	6.66	7.06	7.35	7.02
3.	Air drying	6.96	7.46	7.86	7.55
4.	Freeze drying	7.38	7.96	8.25	7.93
	SEd±	0.10	0.07	0.07	0.15
	C.D.(P=.05)	0.25	0.16	0.18	0.36

3.2.5 Sensory analysis of guava's fruit pulp powder

Organoleptic characters significantly affected by different drying methods, and they are significantly differed from each other except oven drying and air drying which were at par with other. Score for taste (7.38), flavour (7.96), aroma (8.25) and overall acceptability (7.93) were maximum under freeze drying followed by air drying (Table 5). Minimum organoleptic score was found with sun drying method. Due to the extremely low risk of the fruit pulp's originality degrading, freeze drying and air drying kept greater taste, aroma, flavour, and overall acceptability [2,18].

4. CONCLUSION

It may be concluded that guava powder is an excellent source of natural antioxidants and can also be used in place of synthetic antioxidants In this context the drying of guava pulp to generate its powder is very important. The drying is the quite hygroscopic in nature, specifically the freeze drying produced better and finest quality of guava powder riches with ascorbic acid, polyphenolic content, antioxidant activity, and flavor retention.. According to the recent studies, freeze-dried guava powder can be used as a component in the creation of food products with added value because it has a high total phenolic content together with other nutrients. In comparison to conventional drying technologies, this technology has the capability to dry delicate material while maintaining the highest level of nutritional stability. The outcomes for guava powder provided grounds for more research into its potential as a functional food.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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