Chemical Science Review and Letters ISSN 2278-6783

Research Article

Effect of Dehydration on Quality of Bottle Gourd Shreds

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Abstract

Bottle gourd have higher place in daily diet as it contains glucose, pentose, lignin and shikimic acid, vitamins, calcium, iron and phosphorous. To preserve or to prolong the shelf life of fruits and vegetables, dehydration is very important ancient technique along with reduction in size and weight, facilitating transport and reducing storage space. In this research, hybrid dehydration was carried out for 3 mm size steam blanched bottle gourd shreds using microwave continuous dryer and fluidized bed dryer. Shreds were first dried up to 30% moisture contents in microwave continuous dryer and further in fluidized bed dryer at 55-65^{0}C temperature and 6-10 m/s air velocity until final moisture at 6%. Maximum time of dehydration was decreased up to 22.18 % from 55°C temperature and 6 m/s air velocity to 65°C temperature and 10 m/s air velocity during fluidized bed drying. The ascorbic acid content of 3 mm blanched bottle gourd shreds was 7.08 mg/100g and was decreased up to 19.77%. On colour value, the fluidized bed dryer temperature was found significant ($P<0.05$) while air velocity and their interaction was found non-significant. The rehydration ratio was found minimum 9.47 at 55 °C and 10 m/s air velocity while maximum 12.93 at 65 °C and 10 m/s air velocity and was decreased significantly up to 26.75%.

Keywords: Bottle gourd, Steam blanching, Dehydration, Air velocity, Quality characteristics

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Introduction

Fruits and vegetables play a major role in Indian agriculture by providing food, nutritional and economic security and more importantly, producing higher returns per unit area. As compare to fruits, vegetables have higher productivity, shorter maturity cycle and greater income leading to improved livelihoods [1]. Among vegetables bottle gourd have higher place in daily diet. It contains glucose, pentose, lignin and shikimic acid while white raw fruits contain carotene and some vitamins and rich in calcium, iron and phosphorous. The nutritional value of the bottle gourd kernels is equal or better than that of cashew nut and almond kernels. The seed coats are low in fat and protein but quite rich in crude fiber and mineral matter [2]. To preserve and prolong the shelf life of fruits and vegetables, drying is very important ancient technique. Sun drying is the most common method used for preservation of agricultural products in many parts of world. It has some problems related to contamination with dust, soil, sand particles and insects and drying time is quite long. Therefore, in industries mechanical drying is in practice. The main aim of drying is to allow longer periods of storage, minimize packaging requirements and reduce shipping weight [3]. Drying fruits permits their preservation by reducing the water content and therefore inhibiting enzymatic modifications and microbial growth. The important advantages of drying are the reduction in size and weight, facilitating transport and reducing storage space as well as avoiding the expensive cooling systems. Finally, it increases food diversity, allowing alternative ways of consuming foods [4].

Microwave heating is most efficient on liquid water, and much less so on fats and sugars and frozen water [5]. Microwave drying has its inherent advantages over conventional heating such as reducing the drying time of biological material without quality loss. In an industrial level, food processing using this technique has been reported to be both cost-effective and feasible [6]. Microwave dehydration has been successfully tried for different fruits and vegetables. The drying method comprises of subjecting the food pieces to microwave radiation supplying the heat of vaporization directly to water molecules to evaporate the moisture from within food pieces. The moisture content and water activity of the product are thus reduced within a short period of time [7]. It was observed that, microwave drying cause charring of the high moisture products. The drying process using microwaves is known to yield low quality product if not appropriately applied [8]. Hence, microwave drying has usually been combined with other drying techniques including convective hot air, osmotic, vacuum and freeze drying to achieve more uniform, fast and effective drying without significant quality loss. These combined methods have been observed to have enormous potential for high speed and high quality drying [7], [9]. Bottle gourd has higher moisture content and microwave drying alone can cause charring of product which contains high moisture, therefore considerable research was conducted for development of better quality dehydrated bottle gourd shreds with microwave continuous dryer and fluidized bed dryer.

Fluidized bed drying is the drying technique in which fluidization of product is takes place. Fluidization provides better surface area of heat and mass transfer. Fluidized bed dryer provide an effective methodology of drying comparatively free flowing particles with a reasonable narrow particles size distribution. The feed may take the form of powders, granules, crystals, seed and non-friable agglomerates [10]. Dehydration of vegetables shred or pieces in a fluidized bed dryer produces final product of excellent quality in a much shorter time than in continuous belt dryers. Pre-treatments are required to produce final products with having good organoleptic properties, colour, rehydration ratio and uniform quality. Fluidized bed drying is very reliable and most economical method for drying of such type of vegetable pieces and shreds [11]. Therefore to preserve the bottle gourd fruits by removing water to stop the activity of water, microwave drying has been combined with fluidized bed drying to achieve uniform, fast and effective drying without significant losses in the quality of final product.

Materials and Methods

Raw materials and treatments

Fresh bottle gourd fruits of average size and shape were procured from the local vegetable market of Anand, Gujarat, India. The required quantities of material were procured fresh when required, from the same place. Bottle gourd fruits were washed under tap water to remove dust, dirt and other foreign matter. Washed fruits were cut and shredded to 3 mm thick with peel using SS shredder machine. Shreds were steam blanched for 6 min to inactivate the POD enzymes. After blanching, shreds were first dried in microwave continuous dryer (MCD) and then dehydrated in fluidized bed dryer (FBD). In microwave continuous dryer belt speed were kept constant at 0.3 cm/s. In this dryer, drying temperature changes automatically according to product and only belt speed and cut off time are required to be set. In fluidized bed dryer, shreds were dehydrated at different drying temperature at 55, 60 and 65 °C with air velocity at 6, 8 and 10 m/s.

Quality characteristics

Dehydrated final shreds were analyzed for its quality characteristics as ascorbic acid content (mg/100g), colour value (ΔE*ab) and rehydration ratio (%) with its total time required (min).The ascorbic acid content was determined by 2, 6-dichlorophenol indophenols visual titration method described in Ranganna (1986) [12]. Colour value was measured by Lovibond colorimeter (Model RT850i) and rehydration ratio was determined using method described by Pervin *et al.* (2008) [13].

Results and Discussion

Steam blanched bottle gourd shreds of 3 mm sized were first dried up to 30% moisture contents in microwave continuous dryer at 0.3 cm/s conveyor speed and pulsation time for microwave magnetron was 25 sec on and 15 sec off. Further dehydration was carried out in fluidized bed dryer at different drying temperature and air velocity. Time required to dehydrate bottle gourd shreds of all sides were 45 min approximately in MCD, and after that further dehydration was carried out by FBD at different temperature and air velocity until final moisture content achieved at 6%. The effects of drying temperature and air velocity of fluidized bed dryer on quality of bottle gourd shreds was presented in **Table 1** and the statistically mean analyzed data was presented in **Table 2**.

Effect on dehydration time

Time for dehydration of bottle gourd shreds was decreased as the fluidized bed drying temperature and air velocity increased (Table 1). Table showed that the time of dehydration was decreased significantly as temperature increased from 55 to 65°C. Maximum time of dehydration was decreased up to 22.18 % from 55°C temperature and 6 m/s air velocity to 65°C temperature and 10 m/s air velocity during fluidized bed drying. Both the parameters as temperature (FBT) and air velocity (AV) had significant effect individually, however their interaction (FBT*AV) was non-significant ($P<0.05$) (Table 2).

Effect on ascorbic acid content

The data obtained on ascorbic acid from dehydrated bottle gourd shreds was presented in Table 1. The maximum ascorbic acid content was found to be 5.68 mg/100g at 65 °C temperature and 10 m/s air velocity. The ascorbic acid content of 3 mm blanched bottle gourd shreds was 7.08 mg/100g and was decreased up to 19.77% after dehydration in fluidized bed drying at this temperature and air velocity. The ascorbic acid content was found increased significantly in dehydrated shreds as drying temperature (FBT) as well as air velocity (AV) increased (Table 2). The effect of interaction (FBT*AV) was found non-significant. Result indicated that ascorbic acid, a heat sensitive vitamin was decreased with lower temperature and higher exposed time during dehydration.

Table 1 Effect of dehydration temperature and air velocity of fluidized bed dryer on quality of bottle gourd shreds

Air velocity (m/s)	Total Time required for dehydration (min)	Ascorbic acid content (mg/100g)	Colour value (ΔE*ab)	Rehydration ratio (%)
Temperature at 55 ^oC				
6	75.26 ± 0.25	5.39 ± 0.07	1.86 ± 0.32	09.47 ± 0.34
8	74.00 ± 0.50	5.42 ± 0.05	1.83 ± 0.34	09.83 ± 0.63
10	73.30 ± 0.25	5.47 ± 0.02	2.02 ± 0.33	11.94 ± 0.28
Temperature at 60 ^oC				
6	65.46 ± 0.25	5.54 ± 0.03	1.47 ± 0.19	09.60 ± 0.36
8	64.30 ± 0.15	5.53 ± 0.04	1.39 ± 0.79	10.49 ± 0.16
10	63.10 ± 0.10	5.60 ± 0.01	1.81 ± 0.66	12.76 ± 0.16
Temperature at 65 ^oC				
6	60.50 ± 0.30	5.61 ± 0.03	1.62 ± 0.98	11.07 ± 0.21
8	60.00 ± 0.17	5.65 ± 0.01	1.45 ± 0.61	11.13 ± 0.23
10	58.56 ± 0.55	5.68 ± 0.01	1.33 ± 0.25	12.93 ± 0.02

Table 2 Statistically mean analyzed data showing the effect of dehydration temperature and air velocity of fluidized bed dryer on quality of bottle gourd shreds

Treatment	Total Time required for dehydration (min)	Ascorbic acid (mg/100g)	Colour value (ΔE*ab)	Rehydration ratio (%)
Fluidized bed dryer temperature (FBT)				
FBT_1	74.1889	5.4289	1.9089	10.4200
FBT_2	64.3000	5.5578	1.5300	10.9522
FBT_3	59.7222	5.6389	1.4722	11.7133
SEm	0.106	0.013	0.107	0.105
CD	0.314	0.040	0.318	0.313
Air velocity (AV)				
AV_1	67.0778	5.5133	1.6522	10.0522
AV_2	66.1444	5.5367	1.5344	10.4867
AV_3	64.9889	5.5756	1.7244	12.5467
SEm	0.106	0.013	0.107	0.105
CD	0.314	0.040	NS	0.313
Interaction (FBT*AV)				
SEm	0.183	0.023	0.185	0.182
CD	NS	NS	NS	0.542
CV %	0.48	0.72	19.62	2.87
FBT_1 = 55 ^oC, FBT_2 = 60 ^oC, FBT_3 = 65 ^oC and AV_1 = 6m/s, AV_2 = 8m/s, AV_3 = 10m/s				

Effect on colour value

The ΔE*ab value of sample showed the difference between L*, a* and b* of standard and L*, a* and b* of samples. The ΔE*ab value for raw bottle gourd shreds was taken as standard. The ΔE*ab value of dehydrated bottle gourd shreds was found maximum 2.02 at 55 °C temperature and 10 m/s air velocity while minimum was 1.33 at 65 °C temperature and same air velocity during fluidized bed drying (Table 1). The statistical analyzed data (Table 2) revealed that the fluidized bed dryer temperature (FBT) had significant ($P<0.05$) effect on colour value however, air velocity (AV) and interaction (FBT*AV) was found non-significant.

Effect on rehydration ratio

After dehydration of bottle gourd shreds, rehydration ratio was determined by method described in materials and methods. Rehydration ratio was increased as fluidized bed dryer temperature (FBT) and air velocity (AV) of fluidized bed dryer increased (Table 1). The rehydration ratio was found maximum at 10 m/s air velocity irrespective of temperature ranging from 55 to 65 °C. The rehydration ratio was found minimum 9.47 at 55 °C and 10 m/s air velocity while maximum 12.93 at 65 °C and 10 m/s air velocity and were decreased significantly up to 26.75%. The statistical analyzed data (Table 2) showed that individual parameter as fluidized bed dryer temperature (FBT) and air velocity (AV), and their interaction (FBT*AV) had significant effect ($P<0.05$) on rehydration ratio. Rehydration ratio was found higher might be due to less cellular and structural disruption of dehydrated shreds at higher temperature (FBT) and higher air velocity (AV) then the lower temperature and lower air velocity of fluidized bed dryer during dehydration.

Conclusions

To produce good quality dehydrated bottle gourd shreds, it was necessary to optimize various parameters of fluidized bed dryer. Optimization were performed based on minimum dehydration time (min), maximum ascorbic acid content (mg/100g), minimum colour value (ΔE^*ab) and maximum rehydration ratio (%). The minimum dehydration time as 58.56 min, maximum ascorbic acid content as 5.68 mg/100g, minimum colour value as 1.33 ΔE^*ab and maximum rehydration ratio a 12.93 % were obtained at 65 °C fluidized bed dryer temperature (FBT) and 10 m/s air velocity (AV) in 3 mm bottle gourd shreds during dehydration, as it satisfies required statistically and physicochemical quality criteria.

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Publication History

Received	13.08.2019
Revised	26.11.2019
Accepted	27.11.2019
Online	30.11.2019