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Drying characteristics of bitter gourd slices

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Abstract
The present experiment was conducted to study the drying characteristics of bitter gourd slices treated at different concentrations of KMS solution and dried at different drying air temperatures in a tray dryer. Blanched bitter gourd slices were treated with potassium meta bisulphate (KMS) at three different concentrations of 0.2, 0.3 and 0.5%. The treated bitter gourd slices were spread over the trays in a single layer in a tray drier and dried at different temperatures (50, 55 and 60 ºC) until a constant weight was attained. After drying, the samples were taken out and drying characteristics and physical properties such as rehydration ratio, bulk density, particle density and ash content were determined. The results showed that as the drying air temperature increased the drying time reduced. The drying time observed about 285 min to reduce the moisture content of bitter gourd slices from 1698.56 to 5.75% (d.b) pretreated at 0.2% KMS solution and dried at air temperature of 50 ºC. As the temperature of drying air was increased to 55 and 60 ºC for 0.2% KMS concentration of pretreatment, drying time observed nearly 285 and 240 min respectively to reach final moisture content. The maximum rehydration ratio of 6.8 was found for sample dried at 60 ºC and 0.5% KMS solution. Bulk density of the slices increased as the drying air temperature decreased from 60 to 50 ºC. Lowest particle density (0.27 g/cc) and lowest ash content (4.25) were observed for the samples dried at 50 ºC, 0.2% KMS concentration. Finally it was concluded that lowest drying time and high drying rate was observed at 60 ºC and 0.2% KMS solution.

Keywords: Drying air temperature, KMS solution, drying rate, drying time, rehydration ratio, bulk density, particle density and ash content

1. Introduction

Bitter gourd (*Momordica charantia)* is a member of the Cucurbitaceae family and known as Karela commonly in India. In India, it is grown in the area of 97000 hectares with annual production of 1137 metric tons (National Horticulture Board 2017-18). It is an important vegetable of summer as well as rainy season. Immature fruit is a good source of Vitamin C and also contains Vitamin A, phosphorus and iron. Bitter gourd acts as a blood purifier, activates spleen and liver and highly beneficial in diabetes. It is a purgative, appetizer, digestive, anti-inflammatory and has healing capacity. Though it is bitter in taste, this vegetable is valued for its medicinal properties, particularly for the treatment of general fevers, malaria and diabetes (Kedar and Chakraborti, 1982) [4]. Bitter gourd is said to tone-up liver and spleen, useful for diabetic people, diuretic and vermicidal and improves digestion. It is also said to be a good vegetable for patient suffering from ascites, gout and pain in joints. Bitter gourd is also known for its anti-diabetic properties due to its potent oxygen free radical scavenging activity of the fruit juice (Sree Jayan and Rao 1991) [10].

The fruits of bitter gourd are very much consumed as fresh and as dried vegetable for curries, bakery products, pickle or stuffed products of meat. It is also used for the preparation of several dishes. It can be fried, deep-fried, boiled, pickled, juiced, and dried to drink as tea (Myojin *et al.*, 2008) [7]. The seeds of ripe fruits are used as condiment. The fruits are fairly good source of iron, vitamin A, vitamin B, vitamin C and an inexpensive source of protein and minerals (Kumar and Sagar, 2003) [6]. Vitamin C helped stave of blindness, kidney failure and the need for amputation among diabetics (Sagar *et al*., 2008) [9]. Bitter gourd has good demand due fibers (Gopalan *et al.*, 2000) [3].

The preservation of vegetables can avert huge wastage as well as make them available in the lean season at remunerative prices. Drying and canning are two methods which are employed to preserve it. Canning increases the cost of the product due to increasing the cost of cans. Without proper pre-treatment, bitter gourd develops rubbery texture and become brown and in addition to that it also loses some of its bitterness principles, ascorbic acid and chlorophyll during drying (Kumar *et al.*, 1991) [5].

Among the different methods of preservation, drying is one of the best methods of preservation of fresh vegetables. When moisture is removed, they can be preserved over a long period with minimal microbial attack. Drying can reduce the bulk weight of vegetables, protect from browning and can be stored for long period. Blanching as a pretreatment to drying protects their color, texture, nutrients and inactivates harmful enzymes. The heat from blanching helps to slow or stop the enzyme activity that can cause undesirable changes to reduce quality.

In this project, drying of bitter gourd is conducted at three different temperatures 50, 55 and 60 ºC and blanching at three different concentrations 0.2%, 0.3% and 0.5% of KMS solution are used for drying of bitter gourd slices with seeds in a tray drier. In view of the above, the present research was conducted to study the effect of different air temperatures, different concentrations of KMS solution on drying and to determine the drying characteristics of bitter gourd slices.

2. Materials and Methods

2.1 Raw Material

Fresh healthy and unripe bitter gourd vegetables were procured from the local market, Bapatla and are washed thoroughly with clean water to remove dirt adhering. The initial moisture content of bitter gourd was 94.4% w.b. (1698.56% d.b.). Bitter gourd vegetables were cut into uniform thickness of 2 to 4 mm slices.

2.2 Experimental Procedure

Blanching was carried by placing thoroughly washed bitter gourd slices in hot water bath at a temperature of 96 ºC for 3 minutes (Deepak *et.al*). After blanching, the blanched bitter gourd slices were treated with potassium meta bisulphate (KMS) solution at three different concentrations (0.2%, 0.3% and 0.5%) at 28 ºC for 15 minutes. The blanched and pretreated bitter gourd slices were spread over the trays in a single layer in a tray drier and dried at different air temperatures (50, 55 and 60 ºC). The weight of the samples were noted for every 15 minutes till the constant values attained. After drying the samples were taken out from the tray drier and the drying characteristics and the physical properties of dried bitter gourd slices were determined.

2.3 Drying characteristics

2.3.1 Moisture content

The moisture content of the raw materials and dried bitter gourd samples determined by standard A.O.A.C method. Initially cleaned and empty Petri dish for moisture measuring were weighed and noted as W_1 g. Bitter gourd slices were placed in those dishes and noted weight as W_2 g. then dishes were placed in the hot air oven and maintained at 105±1 ºC for 24 hours. The dishes were taken out and placed in desiccator for 5 minutes to cool down. The weight of the boxes along with the dry material were weighed and noted as W_3 g. the moisture content (M.C) was calculated by using the following equation

$$\text{moisture content (w.b.)\%} = \frac{(w_2 - w_1) - (w_3 - w_1)}{(w_3 - w_1)}$$

Where,

W_1 = Weight of the empty dish (g)

W_2 = Weight of the dish + weight of the sample (g)

W_3 = Weight of the dish + weight of bone dry material of the sample (g)

2.3.2 Drying rate

Drying rate was determined by moisture content (% d.b.) decreases of the sample per unit time (min).

$$\text{Drying rate, R} = \frac{\text{Amount of moisture removed}}{\text{Time taken} \times \frac{\text{Total bone dry weight}}{100}}$$

2.4 Determination of physical properties of bitter gourd

2.4.1 Rehydration Ratio

The dehydrated samples were placed in a glass beaker containing 100 ml of water having temperature of 40-45 ºC for 60 minutes. After 60 minutes the rehydrated bitter gourd samples were removed from the glass beaker and excess water was drained off through filter paper. The drained samples weight were note. Rehydration Ratio (RR) in the dehydrated samples were computed using following equation

$$\text{RR} = \frac{C}{D}$$

Where,

C = Drained weight of rehydrated samples (g)

D = Weight of dehydrated samples taken for rehydration test (g)

2.4.2 Bulk Density

Bulk density of bitter gourd slices was measured by gently filling them in a container and the weight was measured using a sensitive balance. Weight of the filled samples was divided by the volume of the container gave the bulk density of the samples (AOAC, 1999) [1].

$$\text{Bulk density, g/cc} = \frac{\text{mass of the dried sample}}{\text{volume of the container}}$$

2.4.3 Particle density

Particle density of bitter gourd slices was determined by using the liquid displacement method. Toluene was used in the place of water because it absorbs caprophores to a lesser extent.

$$\text{Particle density, g/cc} = \frac{\text{mass of the dried sample}}{\text{volume of the sample}}$$

2.4.4 Total Ash

Ash content was estimated according to the method described by AOAC (1999) [1]. Sample was accurately weighted into a cleaned and dried silica crucible. The initial ash was carried over a low flame to char the sample. The crucible was then cooled until a constant weight was achieved and expressed as g/100 g of sample

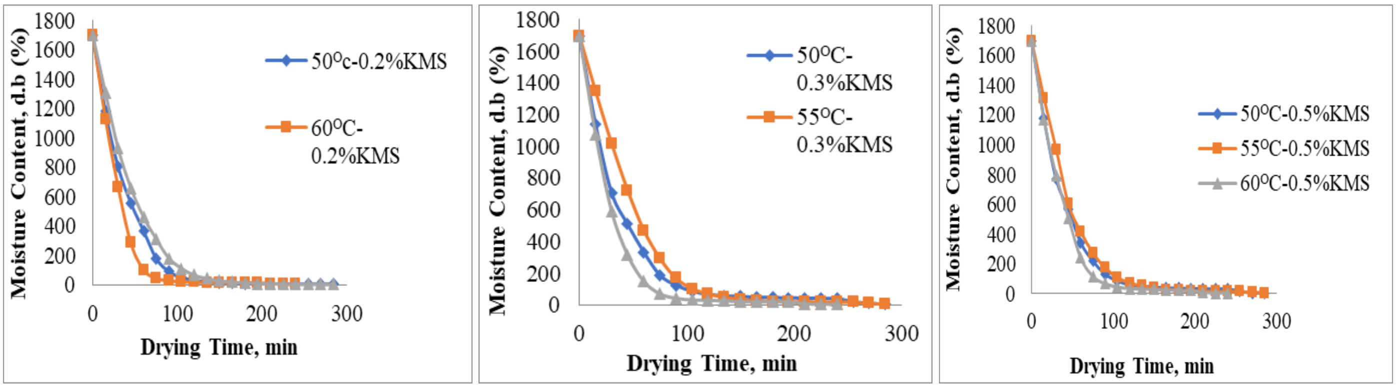
$$\text{Ash content (\%)} = \frac{\text{weight of sample after ashing}}{\text{weight of sample before ashing}} \times 100$$

3. Results and Discussion

3.1 Effect of moisture content with drying time on bittergourd slices

Moisture content of fresh samples was found to be 1698.56%

(d.b.) which was reduced to be less than 4.31% (d.b.) on drying. Initially moisture content of bitter gourd slices decreased rapidly up to 210 minutes of drying and later on drying rate slowed down. It is also observed that as the drying air temperature increased the drying time was reduced. It took nearly 285 min to reduce the moisture content of bitter gourd slices pretreated at 0.2% KMS solution from 1698.56 to 5.75% (d.b) at a drying air temperature of 50 ºC. As the temperature of drying air was increased to 55 and 60 ºC for same concentration of pretreatment, it took nearly 285 and 240 min respectively to reach final moisture content. Similar results were observed for 0.3 and 0.5% KMS concentration also.

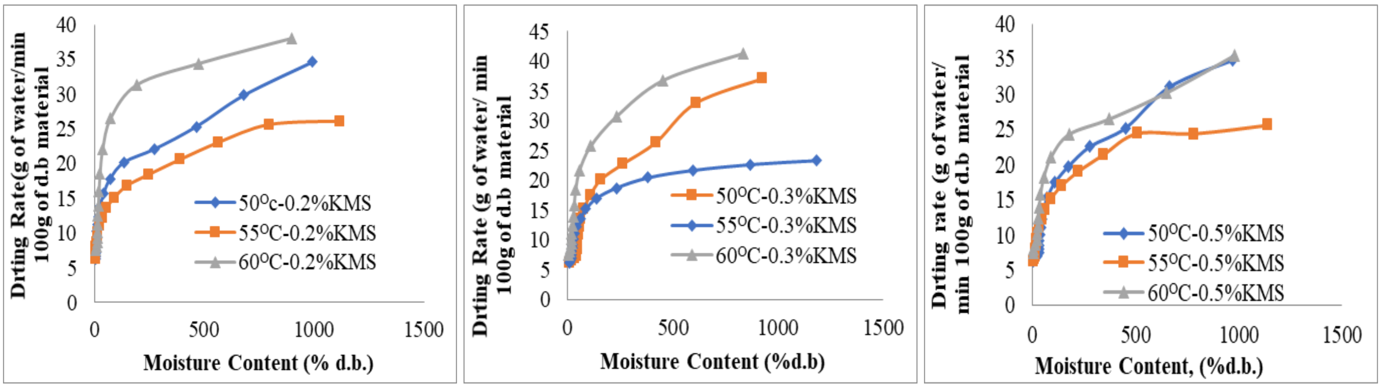


a b c

Fig 3.1: Effect of moisture content of bittergourd slices with drying time at different air temperatures and at KMS solution concentration of a) 0.2%, b) 0.3% and c) 0.5%

3.2 Effect of drying rate with moisture content when the bitter gourd slices are dried at different drying air temperatures

It was observed that the drying rate decreased continuously with decreasing moisture content. This was due to the migration of moisture to the surface and the evaporation rate from surface to air slowed down with decrease of moisture in the product. The rate of moisture loss was more at 60 ºC drying air temperature as compared to the 50 ºC and 55 ºC. This was due to the increased energy of water molecules when the temperature was increased, as the evaporation of water molecules from the sample occurred more quickly.



a b c

Fig 3.2: Effect of drying rate with moisture content of bitter gourd slices dried at different drying air temperatures and different KMS concentrations of a) 0.2% b) 0.3% and c) 0.5%

3.3 Effect drying rate of bitter gourd slices with drying time at different drying air temperatures and different KMS concentrations

It was observed that the drying rate of bitter gourd slices was decreased continuously with increase in the drying time. This was due to the migration of moisture to the surface and the evaporation rate from surface to air slowed down with decrease of moisture in the product. The drying rate was observed more at 55 ºC drying air temperature as compared to the 50 ºC and 60 ºC.

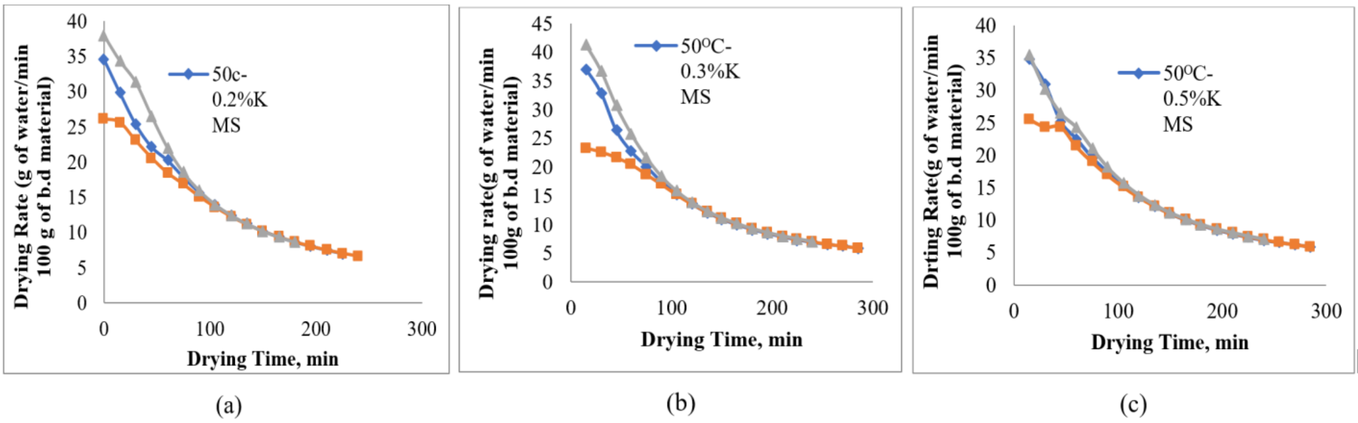


Fig 3.3: Effect of drying rate with drying time at different drying air temperatures and different KMS concentrations

3.4 Determination of physical properties of dried bitter gourd slices

3.4.1 Rehydration ratio

Reconstitution qualities of dried bitter gourd slices were determined by conducting rehydration tests. Rehydration Ratio of dried bitter gourd slices varied in the range of 4.55 to 6.8. The maximum rehydration ratio of 6.8 was found for sample dried at 60 ºC and 0.5% KMS solution while minimum rehydration ratio of 4.55 was found for sample dried at 50 ºC and 0.2% KMS solution.

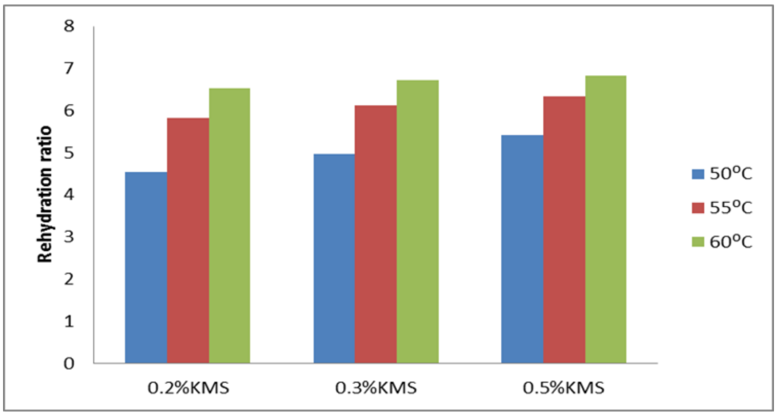


Fig 3.4: Effect of drying air temperatures and % KMS solution on rehydration ratio of Bitter gourd slices

3.4.2 Bulk density

Drying air temperature influenced the bulk density of bitter gourd slices. It was observed that the bulk density of the dried bitter gourd slices increased as the drying air temperature decreased from 60 to 50 ºC. Lowest bulk density of 0.111 g/cc was observed for the samples dried at 60 ºC while the samples dried at 50 ºC recorded the highest value of 0.116 g/cc.

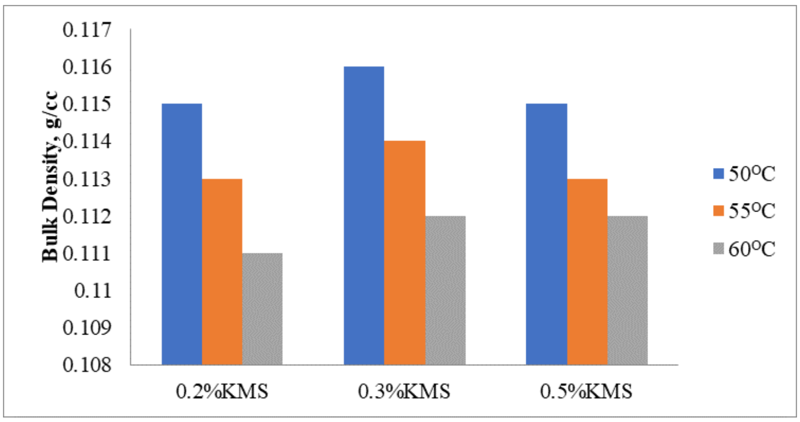


Fig 3.5: Effect of drying air temperature and % KMS solution on bulk density of bitter gourd slices

3.4.3 Particle density

It was observed that the particle density of the bitter gourd slices increased as the drying air temperature increased from 50 to 60 ºC as shown in the figure. Lowest particle density of 0.27 g/cc was observed for the samples dried at 50 ºC, 0.2% KMS concentration while the samples dried at 55 ºC and 0.5% concentration was recorded the highest particle density value of 0.39 g/cc.

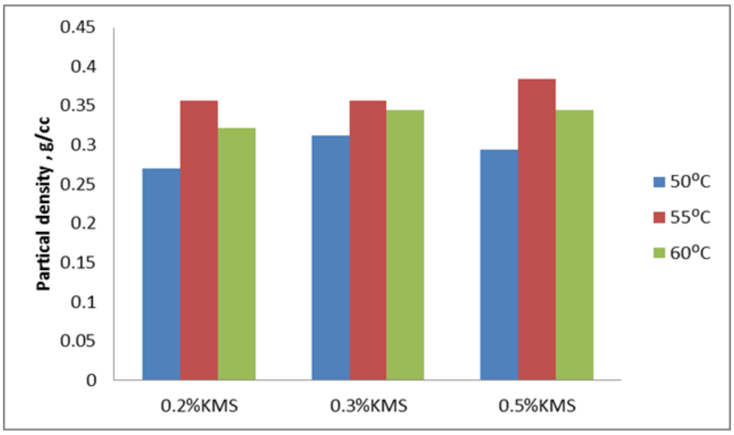


Fig 3.6: Effect of drying air temperature and % KMS solution on particle density of bitter gourd slices

3.4.4 Ash content

Lowest ash content of 4.25% was observed for the samples dried at 50 ºC and 0.5% KMS concentration while the samples dried at 60 ºC and 0.3% concentration was recorded the highest value of 5.6%.

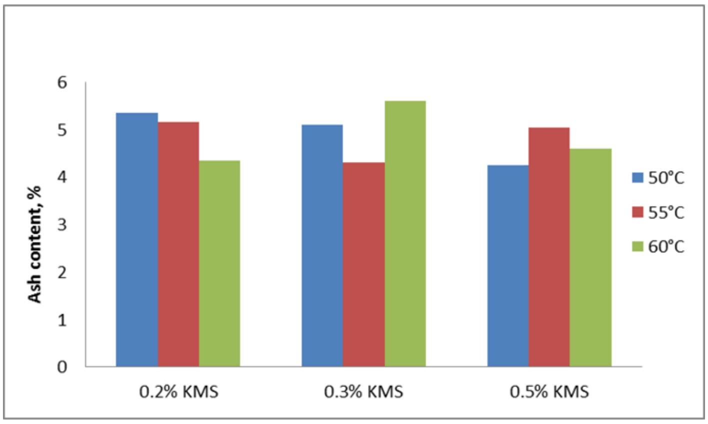


Fig 3.7: Effect of drying air temperature and %KMS solution on ash content of bitter gourd slices

4. Conclusions

The present experiment was conducted on drying of bitter gourd slices treated at different concentrations of KMS solution and dried at different drying air temperatures in a tray dryer. The results showed that as the drying air temperature increased the drying time was reduced. The drying time was observed about 285 min to reduce the moisture content of bitter gourd slices from 1698.56 to 5.75% (d.b) when bitter gourd slices pretreated at 0.2% KMS solution and dried at air temperature of 50 ºC. As the temperature of drying air was increased to 55 and 60 ºC for 0.2% KMS concentration of pretreatment, the drying time was observed nearly 285 and 240 min respectively to reach final moisture content. The maximum rehydration ratio of 6.8 was observed for samples dried at 60 ºC and 0.5% KMS solution. Bulk density of the slices increased as the drying air temperature decreased from 60 to 50 ºC. Lowest particle density (0.27 g/cc) and lowest ash content (4.25) were observed for the samples dried at 50 ºC, 0.2% KMS concentration. Finally it was concluded that lowest drying time and high drying rate was observed at 60 ºC and 0.2% KMS solution.

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