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Research paper

Effect of Vacuum Drying on Chemical Quality of Bitter Gourd

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ABSTRACT

It is the second largest producer of fruits and vegetables in the world, after China. Bitter gourd has twice the calcium and potassium of spinach and banana respectably. It is rich in iron, zinc and good in phosphorus, sodium, magnesium. It is a fair source of vit. C contributes about 55% of total vitamins. Present study was conducted to investigate the effect of effect of vacuum drying on chemical quality of bitter gourd. Mature bitter gourds of uniform medium size and dark green colour were procured, washed and sliced into 1, 2 and 3 cm thick rings with stainless steel knife. After preparation slices were blanched in boiling water at 90°C for 2 minutes. Sulphitation by dipping the blanched bitter gourd slices in 0.2% KMS, 0.2% KMS + 1% Na_2SO_3, 0.1% KMS + 0.05% Citric acid solution for 10 min at room temperature. Salt treatment was given; they were blanched by boiling in 5% NaCl solution. Pretreated bitter gourd slices were spread on a stainless steel tray and dried in vacuum oven dryer at different temperatures 50, 60, 70, 80 °C till bitter gourd crisp or brittle. The lower rehydration ratio of dried sample was found at higher temperature and longer drying time required for drying conditions. DPPH inhibition activity was found lower in all dried samples than fresh. In vacuum oven drying, samples dried at 50 and 60 °C were found to retain higher total phenolic content than 70 and 80 °C.

Keywords: Bitter Gourd, Vacuum Drying, Moisture analysis, Phenolic content, Rehydration Ratio

India's diverse climate ensures the availability of all varieties of fruits and vegetables. It is the second largest producer of fruits and vegetables in the world, after China. As per National Horticulture Database (3rd Advance Estimates) published by National Horticulture Board, during 2021-22, India produced 107.24 million metric tonnes of fruits and 204.84 million metric tonnes of vegetables (APEDA, 2022). Almost all vegetables contain appreciable amount of nutrients. The vegetables are found to be rich source of ascorbic acid, carotene, minerals and fair source of protein, fat, and fiber. *Momordica charantia* L. is known variously as bitter melon, bitter gourd, balsam pear, karalla, African cucumber and bitter cucumber (Heiser, 1979). Bitter gourd has twice the calcium and potassium of spinach and banana respectably. It is rich in iron, zinc and good in phosphorus, sodium, magnesium. It is a fair source of vit. C contributes about 55% of total vitamins. It also has other vitamins such as B_1, B_2, B_3, B_6, B_9, B_{12}, A and K. All the varieties of bitter gourd are found to contain tannin, flavonoids, terpenoids, cardiac glycosides, triterpin, and sterol, resin, amino acid and phenolic content

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(Ullah *et al.* 2011). The bitterness in bitter gourd is due to the cucurbitacin like alkaloid momordicine and triterpene glycoside (momordicoside K and L). The extract of bitter gourd has been reported to have a wide medicinal use in the traditional medical system and most often as hypoglycemic and anti-diabetic agents (Semiz and Sen, 2007). Various preparations of bitter gourd ranging from injectable extracts to fruit juice or dried fruit bits have been used worldwide particularly for blood sugar lowering effect (Welihinda *et al.* 1986; Raman and Lau, 1996). The major compounds that have been isolated from bitter gourd reported to have hypoglycemic actions of potential benefits in diabetes mellitus (Yibchok-Anun *et al.* 2006), including a nature of steroidal saponins known as charantin, insulin-like peptides and vicine. Present study was conducted to investigate the effect of vacuum drying on chemical quality of bitter gourd and the results are reported here

MATERIALS AND METHODS

The raw vegetable namely bitter gourd procured from local market of Varanasi.

Pretreatments for drying of bitter gourd: Mature bitter gourds of uniform medium size and dark green colour were procured and washed in running water to remove dust dirt from its surface. The tail ends of cleaned bitter gourd were cut. These were sliced into 1, 2 and 3 cm thick rings with stainless steel knife. After preparation slices were blanched in boiling water at 90 °C for 2 minutes. Sulphitation by dipping the blanched bitter gourd slices in 0.2% KMS, 0.2% KMS + 1% Na_2SO_3, 0.1% KMS + 0.05% Citric acid solution for 10 min at room temperature. Salt treatment was given; they were blanched by boiling in 5% NaCl solution.

Vacuum Oven Drying: Pretreated bitter gourd slices were spread on a stainless steel tray and dried in vacuum oven dryer (Sonar instrument pvt. Ltd.) at different temperatures 50, 60, 70, 80 °C till bitter gourd crisp or brittle.

Packaging of dried bitter gourd: Dehydrated products were vacuum packed in low density polythene bags having 5 layers, dimension; 26×15 cm of 0.1 mm and Oxygen transmission rate 480 cc/0.001inch/100 inch^2/24h/atm O_2 by using vacuum packaging machine (Induac Saurabh Engineers, INDIA). Packed biter gourd slices were stored at ambient temperature.

Moisture analysis: Moisture content was calculated as per the method of AOAC (2000).

Rehydration ratio: The rehydration ratio of dried bitter gourd slices was determined as the ratio of rehydrated mass to the initial dehydrated mass, which gives a measure of the ability of dried bitter gourd slices to reabsorb water mass (Prakash *et al.* 2004).

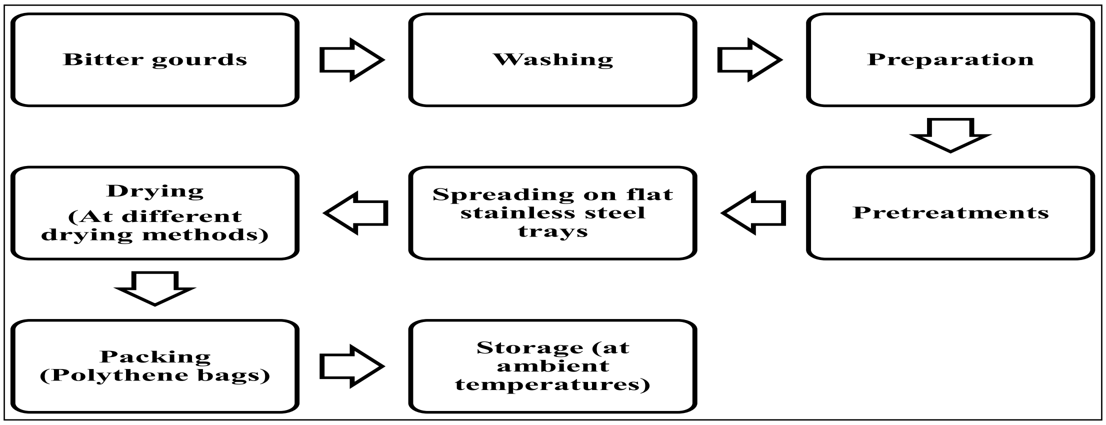

Fig. 1: Flow Chart for Drying of Bitter gourd

DPPH radical scavenging activity: The DPPH radical scavenging activity of bitter gourd was determined according to the methods of Brand-William *et al.* (1995).

ABTS inhibition activity: The ABTS inhibition activity of bitter gourd was calculated according to the methods of (Miller *et al*. 1996).

Phenolic content: The total phenolic content of the bitter gourd was determined according to the Folin-Ciocalteau method as described by Cliffe *et al*. (1994).

RESULTS AND DISCUSSION

Drying Characteristics of bitter gourd slices: The initial moisture content of the bitter gourd slices was found to be 91% (w.b). The drying of bitter gourd slices were done in vacuum oven at different temperatures (50, 60, 70 and 70°C) Time required to dry the [{KMS (0.2%)}, {KMS (0.2%) + Na_2SO_3 (1%)}, {KMS (0.2%) + CA (0.05%)}, {Nacl (5%)}] pretreated bitter gourd slices of 1, 2 and 3 cm thickness in vacuum oven was recorded and shown in the Table 1. It is clear from Table 1, that NaCl pretreated slices of bitter gourd takes more time to dry in comparison to other combination. KMS (0.2%) pretreated slices of 1cm at 80°C in vacuum oven drying was found to require lower time to dry than other drying parameter combinations. Lower drying time in vacuum oven was mainly due to the higher pressure gradient, which helped in faster removal of moisture from the sample. It was found that differences in the slices thickness and in the pretreatments greatly affects the drying time especially at lower drying temperature. Violeta *et al.* (2011) reported similar results in button mushroom slices.

Rehydration Ratio: The rehydration ratio of pretreated bitter gourd slices (1, 2 and 3 cm thickness) is given in Table 2. There was a significant difference in the rehydration ratios among the dried bitter gourd slices. The higher rehydration ratio of samples indicated that the samples retained good texture and absorbed more water. KMS pre-treated 3 cm sample dried at 70°C hold maximum water. Among the slice thicknesses, the rehydration ratio was lower for 1 cm slice. It is also obvious that the dehydration processes that change product composition in lesser

Table 1: Dying time (min) to reduce the moisture content of bitter gourd slices in vacuum oven from 91%(weight basis) to about less than 7% (weight basis)

Sl. No.	Treatments	Temperature (°C)	Slice thickness (cm)		
			1 cm	2 cm	3 cm
1	KMS (0.2%)	50	1250	1380	1530
		60	1140	1290	1435
		70	1035	1145	1335
		80	860	955	980
2	[KMS (0.2%) + Na_2SO_3 (1%)]	50	1255	1385	1540
		60	1145	1300	1440
		70	1040	1155	1340
		80	860	960	985
3	[KMS (0.2%) + CA (0.05%)]	50	1260	1390	1540
		60	1160	1295	1445
		70	1070	1160	1340
		80	865	970	990
4	NaCl (5%)	50	1265	1395	1545
		60	1180	1305	1445
		70	1060	1160	1345
		80	870	965	990

extent are expected to offer better rehydration ratio of the finished product such as freeze and vacuum drying methods. Madamba and Liboon (2001) mentioned that the rehydration ratio of vacuum dried celery was influenced by the temperature, vacuum pressure and slice thickness. Also, Giri and Prasad (2005) suggested that the rehydration ratio could be improved by maintaining lower pressure (higher vacuum) and higher microwave power. The variation in the rehydration ratio values might be influenced by the drying temperature, soaking time, air displacement, pH and ionic strength (Salunkhe, 1991). Among the slice thicknesses, the rehydration ratio was lower for 1 cm slice.

Table 2: Rehydration ratio of dehydrated bitter gourd slices

Sl. No.	Treatments	Temperature (°C)	Slice thickness (cm)		
			1	2	3
1	KMS (0.2%)	50	5.1	5.4	5.5
		60	4.9	5.3	5.5
		70	5.2	5.6	5.4
		80	4.8	5.1	5.0
2	[KMS (0.2%) + Na_2SO_3 (1%)]	50	4.7	5.4	4.9
		60	5.1	5.4	5.3
		70	5.1	5.3	5.3
		80	4.7	4.8	4.9
3	[KMS (0.2%) + CA (0.05%)]	50	4.9	5.2	5.2
		60	5.1	5.2	5.3
		70	5.2	5.3	5.3
		80	4.5	4.7	4.8
4	NaCl (5%)	50	5.2	5.4	5.4
		60	5.1	5.2	5.3
		70	4.8	4.9	5.1
		80	4.7	4.8	5.0

***DPPH Inhibition Activity*:** The DPPH inhibition activity of pretreated bitter gourd slices (1, 2 and 3 cm) is presented in Table 3. KMS (0.2%) pretreated slices of 2 and 3 cm at 60 °C was found to retain higher DPPH inhibition activity than other drying parameter combinations. The higher antioxidant activity of samples indicated that the samples may retain good medicinal properties. Zhang and Hamauzu (2004) reported that raw broccoli florets had total antioxidant activity measured by DPPH with 60.5% but after cooking for 5 min by boiled florets retained 35% and microwaving boiled florets retained 34.7% of total antioxidant activity. Chu *et al.* (2000) have reported that scavenging activities against DPPH of green leaves of potatoes blanched for 2 min at 100 °C remained the same as for fresh ones.

Table 3: DPPH Inhibition activity (%) of dehydrated bitter gourd slices

Sl. No.	Treatments	Temperature (°C)	Slice thickness (cm)		
			1	2	3
1	[KMS (0.2%)]	50	79.2	82.5	81.3
		60	81.1	82.2	81.2
		70	76.3	76.4	76.2
		80	73.3	74.4	74.5
2	[KMS (0.2%) + Na_2SO_3 (1%)]	50	79.5	82.3	81.3
		60	81.2	82.3	76.5
		70	75.4	75.5	75.2
		80	73.3	74.3	74.2
3	[KMS (0.2%) + CA (0.05%)]	50	78.5	81.2	80.1
		60	78.6	80.2	77.6
		70	76.3	76.5	75.3
		80	73.5	74.4	73.3
4	[NaCl (5%)]	50	78.7	81.2	81.1
		60	79.3	81.5	81.1
		70	76.4	76.5	74.5
		80	73.3	73.4	72.6

***ABTS Inhibition Activity*:** The ABTS inhibition activity of pretreated bitter gourd slices (1, 2 and 3 cm) is given in Table 4. KMS (0.2%) pretreated slices of 2 and 3 cm at 60°C was found to retain higher ABTS inhibition activity than other pretreatment, temperature and slice thickness combinations in vacuum oven drying. The ABTS inhibition activity was found to be lower than DPPH inhibition activity at same conditions. The analysis indicated that there was a significant difference in the ABTS inhibition activity among the dried bitter gourd slices.

***Total Phenolic Content*:** Total phenolic content (mg/g) of dehydrated bitter gourd slices is presented in Table 5. KMS (0.2%) pretreated bitter gourd slices of 2 and 3cm at lower temperature of 50 and 60 °C

Table 4: ABTS Inhibition activity (%) of dehydrated bitter gourd slices

Sl. No.	Treatments	Temperature (°C)	Slice thickness (cm)		
			1	2	3
1	[KMS (0.2%)]	50	71.3	72.6	73.4
		60	73.1	73.5	73.7
		70	69.4	70.3	70.8
		80	68.3	68.5	68.4
2	[KMS (0.2%) + Na_2SO_3 (1%)]	50	71.8	72.6	72.7
		60	71.1	73.2	73.0
		70	68.6	69.3	69.1
		80	67.3	67.5	68.3
3	[KMS (0.2%) + CA (0.05%)]	50	71.0	71.4	71.8
		60	71.1	71.8	71.5
		70	69.7	71.4	72.0
		80	67.2	68.5	68.3
4	[NaCl (5%)]	50	71.6	71.6	71.8
		60	69.5	71.4	70.8
		70	67.2	68.5	67.6
		80	66.5	67.1	67.2

Table 5: Total phenolic content (mg/g) of dehydrated bitter gourd slices

Sl. No.	Treatments	Temperature (°C)	Slices Thickness (cm)		
			1	2	3
1	[KMS (0.2%)]	50	5.8	6.2	6.3
		60	6.1	6.3	6.3
		70	5.5	56	6.1
		80	5.4	5.5	5.1
2	[KMS (0.2%) + Na_2SO_3 (1%)]	50	5.8	6.	6.1
		60	5.5	6.1	6.1
		70	5.4	6.1	6.2
		80	5.4	5.6	5.6
3	[KMS (0.2%) + CA (0.05%)	50	5.7	5.2	6.2
		60	5.6	6.4	6.1
		70	5.4	6.3	5.7
		80	5.4	5.6	5.6
4	[NaCl (5%)]	50	5.6	6.3	6.1
		60	5.4	5.5	6.2
		70	5.4	5.4	5.5
		80	5.3	5.4	5.4

was found to retain higher total phenolic content than other pretreatment, thickness and temperature combination conditions. Decreasing temperature of processing was also found to preserve 80-100% of phenolic content in some vegetables (Roy *et al.* 2007). Semi drying of tomatoes was found to lower the phenolic content by 30%, but drying of pepper gave contradicting results (Toor and Savage, 2006).

CONCLUSION

It was concluded that the lower rehydration ratio was found at higher temperature and longer drying time required for drying conditions. DPPH inhibition activity was found lower in all dried samples than fresh. In vacuum oven drying, samples dried at 50 and 60 °C were found to retain higher total phenolic content than 70 and 80 °C.

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