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Optimization of process parameters for production of bottle gourd powder

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ABSTRACT : The bottle gourd is having tremendous health benefits. However, process of consuming fresh bottle gourd to meet daily recommended requirement is tedious. The easy way is to consume bottle gourd in powder form which also avoids pains and drudgery involved in its daily processing. This can help to make it available as and when required. But there is no standard process available for the preparation of bottle gourd powder having optimum quality attributes. Hence, the study was undertaken to find out the effect of different pretreatment such as steam blanching time and drying air temperature on the quality attributes of bottle gourd powder. Bottle gourd powder was prepared by varying process parameters *viz.*, steam blanching time (2, 4, 5 and 8 min) and drying air temperature (50, 60, 70 and 80^{0}C) and compared with treatment without blanching. Quality attributes of bottle gourd powder such as bulk density, water absorption capacity, ascorbic acid and potassium were determined. Sensory evaluation of bottle gourd powder was performed. Steam blanching pretreatment (6 min) prior to hot air drying (60^{0}C) was found to be the most effective to obtain better quality bottle gourd powder. The bottle gourd powder prepared by the developed process technology was highly consumer acceptable.

KEY WORDS : Bottle gourd powder, Steam blanching, Ascorbic acid, Potassium

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Bottle gourd (*Lagenaria siceraria mol. Stand* L.) is an important vegetable crop of tropical and sub tropical regions of the world belonging to the family cucurbitaceae. It is very popular throughout India and almost all the year round the fruit are available in the market. Bottle gourd is good source of Vitamin B and ascorbic acid is having cool effect on human body and easy to digest (Singh and Singh, 2005). It gives relief to patients suffering from urinary disorders, heart problems, insomnia and diabetes (Gopalan *et al.*, 2004). Bottle gourd is very useful to maintain cholesterol level in blood and reduces the impact of low blood pressure and heart diseases which are found most commonly among people.

Bottle gourd contents 1.6 per cent choline on a dry weight basis; a precursor to acetylcholine, a chemical used to transfer nerve impulses and hence, it is believed to have neurological effects (Thomas, 2008). Bottle gourd contains cucurbitacins, polyphenols and two sterols namely; campesterol and sitosterol (Ghule *et al.*, 2007). Bottle gourd is well known for their immunomodulatory, hepatoprotective, antioxidant, anti-stress, adaptogenic, analgesic, anti-inflammatory, cardio-protective, cardio-tonic, antihyperlipidemic, diuretic, aphrodisiac, alternative purgative, antidote to certain poisons and cooling properties (Ahmad *et al.*, 2011; Deshpande *et al.*, 2008 and Mohale *et al.*, 2008).

It is difficult to consume fresh bottle gourd to meet daily recommended requirement because of tedious task of processing. For convenience in adoption of bottle gourd, it needs to be converted into dried powder form so as to make it available as and when required. Preparation of bottle gourd powder will also help to establish small scale industries in urban areas due to high scale demand. Preparation of bottle gourd powder is one of the viable technologies for utilization of bottle gourd fruits. However, standard process for preparation of bottle gourd powder is not available having optimum quality attributes. It is, therefore, necessary to optimize the process parameter like blanching time and drying temperature in the preparation of bottle gourd powder. In view of these facts, bottle gourd powder was prepared by varying process parameter and evaluated for its quality characteristics to standardize the process parameters.

METHODOLOGY

Sample preparation :

Fresh light green, well matured, uniform size bottle gourd fruits of Samrat variety were obtained from local market. The fruits were thoroughly washed after sorting and grading. Fruits were cut into two halves along its vertical axis and non-edible portion was scooped out with the help of spoon and cut into shreds. Thickness of shreds was maintained as 3 mm with the help of stainless steel knife. The relevant physical properties of bottle gourd shreds namely moisture content, ascorbic acid content and potassium were determined following standard procedures in the laboratory. The potassium in sample was determined by using Flame photometry technique (Gupta, 1999).

Steam blanching of bottle gourd shreds :

A deep pot with tight fitting lid and a wire basket was used for steam blanching. The water was added to the pot and brought to a rolling boil. Bottle gourd shreds were kept at 2 inches deep loosely in the basket. Basket with shreds was placed in the pot making sure that water does not come in contact with the bottle gourd shreds. Pot was covered for varying blanching time as 2, 4, 6 and 8 min, respectively.

Drying of steam blanched bottle gourd shreds :

The bottle gourd shreds were subjected to thin layer hot air drying in a cabinet dryer at constant air velocity of 1.5 m/sec. Drying temperature was chosen as independent variable with four levels of 50, 60, 70 and 80^{0}C, commonly employed for commercially drying of fruits and vegetables and based on some preliminary trials. Sample without blanching was used as control sample which also was dried at above drying temperature levels. Total twenty experiments were conducted to study the effect of independent variables such as steam blanching time and drying temperature on various quality attributes of dried products. The experiments were replicated thrice. The initial sample size was maintained as 1200 g, which fully covered the tray in a single thin layer. A sample size of approximately 100 g out of the lot was kept separate in a small aluminium wire mesh tray in the drying chamber and was used for accurate determination of moisture content.

The initial moisture content of the sample was determined and the weight of the sample was monitored at every 15 min interval during experiment. Drying was concluded at equilibrium between the sample and drying air which was indicated by at least two consecutive almost constant readings. One trial of each drying run was terminated when the sample attained a weight corresponding to a moisture content of approximately 0.04 kg water per kg of dry matter, as set out in the standard ISO-5560-1983 (Vazquez *et al.*, 1999). The dried bottle gourd shreds were allowed to cool at room temperature and then ground in a mixer. Ground sample were then sieved with 30 mesh sieve and immediately transferred and sealed in zip-lock bags. These packets were stored in desiccators for investigating the quality of the dried product later on.

Quality assessment of bottle gourd powder :

To assess the quality of the product the quality attributes such as bulk density, water absorption capacity, ascorbic acid and potassium were determined. Bulk density was determined by filling the sample gently in a container of known volume and weighed. The ratio between the weight and volume was calculated as bulk density and expressed as g/ml (Bodhankar, 1992). For water absorption capacity was determined following the standard process (Bodhankar, 1992). In a weighed centrifuge tube 5 g of sample and 30 ml of distilled water was added and material was suspended in water by mixing with a thin glass rod such that no sample adhered to the side of centrifuge tube. After a holding period of 30 min, 10 ml of distilled water was used to wash the sample adhering to the stirring rod and centrifuge tube if any. The suspension was then centrifuged at 3000 rpm for 15 min. The supernatant liquid was discarded and the tube kept mouth down at an angle of 15-20 in forced air oven at 50^{0}C. It was placed in desiccators at room temperature and subsequently weighed. Water absorption capacity was calculated as the amount of water retained by 100 g of sample and expressed in per cent.

Optimization of process parameter :

The experimental designed was aimed at optimization of process parameter for preparation of bottle gourd powder with total twenty experiments. A two factorial design was used with four level of each variable. The two independent variables (factors) were blanching time and drying air temperature. The treatment combinations were tested in random order. Response surface methodology (RSM), (Mayer, 1971) was used to estimate effect of process variables on bulk density, water absorption capacity, ascorbic acid and potassium. Sensory evaluation of bottle gourd powder was performed.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Effect of process variable on bulk density of bottle gourd powder :

The measured values for bulk density with different combination of process parameter varied between 0.478 to

0.496 g/ml with the combination of variable studied (Table 1). The first order polynomial model was fitted with the experimental data.

Table 1 : Measured values of quality attributes of bottle gourd powder

Treatments	Bulk density (g/ml)	Water absorption capacity (%)	Ascorbic acid (mg/100 g)	Potassium (mg/100 g)
T_1S_0	0.496	94.3	14.29	2300
T_1S_1	0.495	112	14.03	2100
T_1S_2	0.489	122.2	12.73	2000
T_1S_3	0.483	124.6	11.39	1950
T_1S_4	0.482	126.1	9.99	1900
T_2S_0	0.494	96.6	14.20	2400
T_2S_1	0.493	114.2	14.0	2310
T_2S_2	0.488	123	12.65	2200
T_2S_3	0.482	125.3	11.26	2100
T_2S_4	0.481	127	9.81	2000
T_3S_0	0.493	126.21	14.16	2402
T_3S_1	0.491	114.22	13.96	2210
T_3S_2	0.487	113.97	12.55	2101
T_3S_3	0.481	121.23	11.10	2043
T_3S_4	0.480	124.75	9.60	2390
T_4S_0	0.491	96.01	14.10	2398
T_4S_1	0.489	96.23	13.90	2205
T_4S_2	0.484	115.12	12.43	2112
T_4S_3	0.480	124.23	10.93	1995
T_4S_4	0.478	125.98	9.38	2397
SE	0.0029	0.442	0.022	19.28
CD	0.0082	1.225	0.061	53.36
F	4.45*	706.8*	634.39*	133.3*

* indicate significance of values at P=0.05, respectively
T_1=50°C, T_2=60°C, T_3=70°C, T_4=80°C, and S_0=0 min S_1=2min, S_2=4min, S_3=6min

$$\text{Bulk density (Bd)} = 0.499 - 0.00150X_1 - 0.00017X_2 \quad (R=0.75)$$

Equation 1 shows the predicted value of bulk density (Bd) as a function of steam blanching time (X_1) and drying air temperature (X_2). Inspection of the co-efficients variable in equation 1 suggested that steam blanching (X_1) was the major factor contributing in decrease of bulk density followed by drying air temperature (X_2). The negative co-efficient of these variables (X_1 and X_2) revealed that an increase in their variables decreased the bulk density. High F value observed for treatments indicated its significance at 5% level (Table 1).

Effect of process variable on ascorbic acid of bottle gourd powder :

Ascorbic acid was observed as an important factor to be considered for optimizing the process parameter. Maximum retention of ascorbic acid is desired in the bottle gourd powder. Regression model was fitted adequately to the observed data with high co-efficient of co-relation (R=0.95). High value of the co-efficient of correlation (R=0.95) obtained for the response variable indicated that the developed model for the ascorbic acid accounted for and adequately explain 95% of the total variation.

$$\text{Ascorbic acid (AA)} = 13.23 - 0.590X_1 - 0.0128X_2 \quad (R = 0.95)$$

The magnitude of co-efficient of variables in Equation 2 indicated that steam blanching time (X_1) have maximum influence on ascorbic acid content followed by drying air temperature (X_2). The negative co-efficient of both the process variable (X_1 and X_2) in the Eqn. 2 revealed that ascorbic acid content of bottle gourd powder decreased with increase in steam blanching time (X_1) and drying air temperature (X_2). Taiwo and Adeyemi (2009) also reported similar trend for apple and banana slices. Decrease in ascorbic acid with increase in steam blanching time and drying air temperature may be due to the reason that ascorbic acid is very sensitive to oxidation and heat. Therefore higher losses in ascorbic acid during drying were also reported by Singh *et al.* (2006). Similar findings regarding ascorbic acid degradation were also reported by Sawate *et al.* (2009) and Ranganna (2004) .

There is no much difference in decrease in ascorbic acid content in 50 and 60^0C as compared to 70 and 80^0C. As blanching time increases ascorbic acid content decreases but there is no significant difference in ascorbic acid retention with increase in blanching time. Therefore 6 min blanching time and 60^0C drying air temperature was found to be optimum treatment for the production of bottle gourd powder.

Effect of process variable on water absorption capacity of bottle gourd powder :

The measured values of water absorption capacity of bottle gourd powder with different combinations of process parameters (Table 1) varied in the range of 94.3 to 126.21 per cent within the combination of variable studied. The relationship was obtained with values of steam blanching time (X_1) and drying air temperature (X_2). The relationship developed with independent variables was as follows:

$$\text{Water absorption capacity (WC)} = 106.8 + 3.646X_1 + 0.176X_2 \quad (R=0.83)$$

The positive co-efficient of steam blanching time (X_1) indicated that water absorption capacity increased with increase in these variables. The high value of F observed for treatments indicated its significance at 5% level (Table 1). It was observed that at higher drying air temperature of 70 and 80^0C, there is no significant increase in the water absorption capacity as compared to 50 and 60^0C drying air temperature.

Effect of process variable on potassium content of bottle gourd powder :

Potassium content of bottle gourd powder was measured for different combinations of process variables and it varied between 1900 to 2700 mg/100 g within the combination of variable studied. The best fit was obtained with co-efficient of correlation (R=0.98) which showed that the model developed was adequate for the experimental data.

$$\text{Potassium (K)} = 1682.14 - 0.255\,X_1 + 10.732\,X_2 \quad (R=0.98)$$

Inspection of the Eqn. 4 revealed that the potassium of the bottle gourd powder decreased with increase steam blanching time (X_1) but increased with increase in drying air temperature (X_2). The potassium content in fresh bottle gourd was 86 mg per 100 g was significantly lower than the potassium content in bottle gourd powder (2700 mg / 100 g). This may be due to increase in concentration of potassium after drying.

Table 2 : Sensory score of quality attributes of bottle gourd powder by varying steam blanching time

Judges/	Colour					Flavour					Taste					Texture					Overall acceptability				
Samples	S_0	S_1	S_2	S_3	S_4	S_0	S_1	S_2	S_3	S_4	S_0	S_1	S_2	S_3	S_4	S_0	S_1	S_2	S_3	S_4	S_0	S_1	S_2	S_3	S_4
1.	4	6	7	9	7	3	7	7	8	7	3	7	7	8	6	3	7	7	7	7	3	6	7	8	7
2.	4	6	6	9	7	2	7	7	7	7	2	7	7	9	6	3	7	7	7	6	3	7	7	9	7
3.	3	6	7	8	7	3	7	7	8	7	2	6	6	9	5	3	7	7	7	7	3	6	7	8	7
4.	4	6	7	9	9	2	9	9	8	7	2	7	7	8	5	3	7	7	7	7	3	6	7	9	7
5.	4	7	7	9	6	3	7	7	7	7	3	7	7	8	5	3	6	6	6	6	2	6	6	9	6
6.	4	6	7	8	6	3	7	7	8	7	3	6	7	9	5	2	7	6	6	6	3	6	7	8	6
7.	3	7	7	9	6	3	7	7	7	7	3	7	7	8	6	2	7	7	6	6	3	6	6	9	6
8.	4	7	8	9	7	3	7	7	7	7	3	7	7	9	6	3	7	7	7	7	3	6	7	8	7
9.	3	7	8	9	6	3	7	7	8	7	3	7	7	8	5	3	7	6	6	6	3	6	6	9	6
10.	4	6	7	9	6	3	7	7	7	7	3	6	7	8	5	3	7	7	7	6	2	6	7	8	7
S.E.	0.212					0.264					0.234					0.234					0.187				
C.D.	0.587					0.731					0.649					0.647					0.519				
F	7.5*					2.46 NS					8.26*					1.45 NS					12.24*				

NS = Non-significant

* indicate significance of value at P=0.05, respectively

S_0 – without blanched sample; S_1 – 2 min steam blanched sample; S_2 - 4 min steam blanched sample; S_3 - 6 min steam blanched sample; S_4 - 8 min steam blanched sample

Table 3 : Sensory score of quality attributes of bottle gourd powder sample for varying drying air temperatures

Judges/	Colour				Flavour				Taste				Texture				Overall acceptability			
Samples	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
1.	8	9	7	6	7	8	7	7	7	8	7	6	7	7	7	7	7	8	6	6
2.	7	8	7	7	7	9	7	7	7	9	7	6	7	7	7	7	7	9	6	6
3.	8	9	7	6	7	9	7	6	7	9	6	6	8	8	8	8	7	9	6	6
4.	7	8	6	6	7	8	7	7	7	9	7	7	8	8	8	8	8	9	6	6
5.	8	6	7	6	7	9	7	6	7	9	7	6	7	7	7	7	8	9	6	6
6.	8	6	7	7	7	9	6	6	7	8	7	7	7	7	7	7	7	8	6	6
7.	8	6	7	7	7	9	7	7	7	8	7	6	8	8	8	8	8	9	7	7
8.	8	8	7	7	7	9	7	7	6	8	7	6	7	7	7	7	8	9	7	6
9.	8	9	7	6	7	9	8	7	7	9	7	7	7	7	7	7	8	9	7	7
10.	8	9	7	7	7	8	6	6	7	9	7	6	8	8	8	8	7	8	6	6
S.E.	0.244				0.245				0.177				0.156				0.212			
C.D.	0.676				0.679				0.489				0.431				0.588			
F	9.48*				6.16*				16.30*				1.83 NS				11.55*			

NS = Non-significant

* indicate significance of value at P=0.05, respectively

T_1 – sample dried at 50 ^{0}C; T_2 – sample dried at 60 ^{0}C; T_3 – sample dried at 70 ^{0}C; T_4 – sample dried at 80 ^{0}C

Table 4 : Sensory score of quality attributes of bottle gourd powder prepared with standardize process with commercial market sample

Judges/ Samples	Colour		Flavour		Taste		Texture		Overall acceptability	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
1.	9	6	8	7	8	7	8	9	8	8
2.	8	7	8	8	8	8	9	8	9	8
3.	8	6	7	6	8	7	7	6	8	6
4.	9	7	8	7	8	7	8	9	8	8
5.	9	8	8	7	8	8	8	8	9	9
6.	9	8	8	8	9	8	8	7	9	8
7.	9	7	9	8	9	8	9	8	9	8
8.	8	7	9	8	8	8	9	8	8	8
9.	8	8	8	7	8	7	8	8	9	8
10.	8	7	8	7	8	8	8	8	9	9
S.E.	0.282		0.0942		0.115		0.150		0.115	
C.D.	0.903		0.301		0.368		0.482		0.368	
F	12.2*		36*		13.50*		3.29 NS		13.50*	

NS = Non-significant * indicate significance of value at P=0.05, respectively S_1 – Sample prepared by standardized process ; S_2 – Market sample

Potassium is used as an electron carrier in the body. It is a mineral and is important for vital body functions such as acid base and water balance. At higher drying air temperature such as 70 and 80 ^{0}C there is loss of potassium content. From Table 1 it is clear that high F value observed for treatments indicated its significance at 5 per cent level.

Sensory evaluation of bottle gourd powder by varying steam blanching time :

The mean score for colour, flavour, taste and overall acceptability indicated that S_3 sample (6 min blanching time) was significantly superior compared to other samples at 5 per cent level (Table 2). The difference in the colour of the samples may be attributed to exposure of bottle gourd powder to higher blanching time during the product preparation process. It was also observed that there is loss of desired colour in the without blanched sample (control) as compared to steam blanched sample.

Sensory evaluation of bottle gourd powder by varying drying air temperatures

It is clearly evident that steam blanched bottle gourd shreds (blanching time 6 min) dried at 60^{0}C was found superior with respect to the quality attributes *viz.*, colour and appearance taste, flavour and overall acceptability (Table 3).

Comparison of prepared bottle gourd powder with commercial market sample through sensory evaluation :

The mean score for colour presented in Table 4, indicated that bottle gourd powder prepared by standard process was significantly superior to the market sample with respect to colour, flavour, taste and overall acceptability. There was maximum retention of light green colour in the steam blanched sample than market sample. The retention of the greenish colour may be due steam blanching treatment. The developed sample was well accepted with respect to all quality attributes.

Conclusion :

Steam blanching pre treatment (6 min) prior to hot air drying (60^{0}C) was found to be the most effective treatment to obtain better quality bottle gourd powder. The bottle gourd powder prepared by the developed process technology was highly consumer acceptable.

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REFERENCES

Ahmad, I., Irshad, M. and Rizvi, M.M.A. (2011). Nutritional and medicinal potential of Lagenaria siceraria. *Internat. J. Veget. Sci.,* **17**(2): 157-170.

Bodhankar, S.S. (1992). Preparation and qualities of weaning food. M. Tech. Thesis, Marathwada Agricultural University Parbhani, M.S. (INDIA).

Deshpande, J.R., Choudhri, A.A., Mishra, M.R. Meghre, V.S., Wadodkar, S.G. and Dorle, A.K. (2008). Beneficial effects of Lagenaria siceraria (Mol.) standley fruit epicarp in animal models. *Indian J. Exp. Biol.,* **46**(4): 234-242.

Ghule, B.V., Ghante, M.H., Yeole, P.G. and Saoji, A.N. (2007). Diuretic activity of Lagenaria siceraria fruit extracts in rats. *Indian J. Pharm. Sci.,* **69**(6): 817-819.

Gopalan, C., Rama Sastri, B.V. and Balasubramanian, S.C. (2004). *Nutritive value of Indian Foods*. National Institute of Nutrition, Hyderabad (A.P.) INDIA.

Gupta, P.K. (1999). *Soil, plant, water and fertilizer analysis.* Pub. Agro. Botanica IV-E 176 J.N. Vys Nagar, Bikaner (RAJASTHAN) INDIA.

Mayer, R.H. (1971). *Response surface methodology*. Allyn and Bacon, Inc. Boston, USA.

Mohale, D.S., Dewani, A.P., Saoji, A.N. and Khadse, C.D. (2008). Antihyperlipidemic activity of isolated constituents from the fruits of Lagenaria siceraria in albino rats. *Internat. J. Green Pharm.,* **2**(2): 104-107.

Ranganna, S. (2004). *Hand book of analysis and quality control for fruit and vegetable products*.Tata McGraw-Hill Publications, NEW DELHI, INDIA.

Sawate, A.R., Bhokdre, C.K., Kshirsagar, R.B. and Patil, B.M. (2009). Studies on preparation and quality evaluation of powder and candy from bottle gourd beverage and Food World, 27-31.

Singh, D.K. and Singh, S.K. (2005). *Nutritional security of horticultural crops.* Elements of Horticulture. Agrotech Publishing Academy, Udaipur (RAJASTHAN) INDIA .

Singh, V., Behera, T.K., Sagar, V.R. and Kumar, S.P. (2006). Effect of drying conditions on the quality of dehydrated selected leafy vegetables. *J. Food Sci. & Technol.,* **43**(6) : 579-582.

Taiwo, K.A. and Adeyemi, O. (2009). Influence of blanching on the drying and rehydration of banana slices. *African J. Food Sci.*, **3** (10) : 307-315.

Vazquez, G. Chenol, F., Moreira, R. and Castoyas, A. (1999). The dehydration of garlic I. Desorption isotherm and modeling of drying kinetics. *Drying Technol.,* **17**(6) : 1095-1108.

Thomas, S.C. (2008). Nutritional and therapeutic values of vegetables in: Vegetables and Fruits: Nutritional and Therapeutic Values, Chap. 1. CRC Press, LONDON, UNITED KINGDOM.

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