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Standardization of a method for the development of hurdle processed bitter gourd rings

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ABSTRACT

Hurdle processed bittergourd rings were prepared from cvs. Pusa Domousmi and Pusa Hybrid 1 using different pre-treatments of salt and sugar solution dip. It was observed that bittergourd rings prepared by soaking in 10 per cent NaCl salt solution in a 1:5 ratio at 30°C for 12 h gave the best results, irrespective of the cultivar studied. Nutritional quality as well as sensory characters were assessed. The pH, ascorbic acid and tannin content of Pusa Domousami were greater than Pusa Hybrid 1. The bitterness and antioxidants of fruits of Pusa Hybrid 1 and Pusa Domousami were found to be 0.117 and 0.012 per cent and 508 and 247 µM Fe II, respectively. The rings of most acceptable treatment exhibited a_w of 0.714.

Key words: Hurdle technology, bitter gourd, quality parameters, bitterness, antioxidant activity.

INTRODUCTION

Bitter gourd (*Momordica charantia*) is a common vegetable cultivated throughout India during the warm season. It is native to Asia but now widely grown worldwide. The seeds of ripe fruits are used as condiment (Kalra *et al.*, 4). It is one of the most popular vegetables in India and is cultivated over an area of 26,004 ha with an annual production of 1,62,196 tonnes (Sidhu, 10). It has got medicinal value and great export potential. It constitutes 20 per cent of the total export of fresh vegetables (Sidhu, 10). Bitter gourd fruits are used as vegetable dried, curried, baked, pickled or stuffed (Sethi *et al.*, 9). Fruits are also utilized in the preparation of pickles and stored as a dry vegetable (Suresh and Sagar, 11).

The concept of hurdle technology which envisages the production of safe, stable, nutritious, tasty and economical foods is an intelligent combination of various preservation techniques to achieve multi target, mild but reliable preservation effects. The concept has proved very successful in achieving microbial stability and safety while stabilizing the sensory and nutritive properties of foods. The future trend of minimally processed foods already incorporates the concept of hurdle technology to prepare convenient and high quality foods by combining a set of mild hurdles. Keeping the above points in view, the present study was carried out to standardize an appropriate and simple process using various hurdles (factors) for preservation of bitter gourd rings.

MATERIALS AND METHODS

Bitter gourd cv. Pusa Domousmi and Pusa Hybrid 1 were taken from the Research Farm of the Division of Vegetable Science, IARI, New Delhi. Firm mature fruits were washed thoroughly, the ends were cut and rest of the fruits was cut into 1.5 cm thick rings. The rings were subjected to hot water blanching for 1-4 min. except the control lot. The best blanching time was determined by peroxidase test. The prepared bitter gourd rings (both blanched and unblanched) were subjected to soaking in different osmotic solutions having different ratios for rings: solution, *i.e.* TB_1 = Salt 10 per cent; TB_2 = Salt 15 per cent; TB_3 = Sugar 15 per cent; TB_4 = Salt 10 per cent + sugar 15 per cent; TB_5 = Salt 10 per cent + sugar 30 per cent; TB_6 = Salt 10 per cent + sugar 45 per cent; TB_7 = Salt 15 per cent + sugar 15 per cent; TB_8 = Salt 15 per cent + sugar 30 per cent; TB_9 = Salt 15 per cent + sugar 45 per cent; TB_{10} = Control.

The blanched and unbalanced rings (250 g/ treatment/ replication) were subject to soaking in osmotic solution at different soaking ratios of 1:4, 1:5 and 1:6. Three repetitions were tried and the best treatment was identified on the basis of solid gain (%), moisture loss (%), weight loss (%), yield of the prepared product and organoleptic evaluation. In the best osmotic treatment, citric acid (0.9%) and KMS (0.1%) were incorporated. The rings were added in the soaking solution (heated to 30-50°C) for 4-12 h. Control lot was kept where soaking solution was kept at ambient temperature (28 ±1°C) at 30, 40, 50°C for 4, 8 or 12 h. The best temperature of soaking solution and time for soaking was determined on the basis of solid gain (per cent), moisture loss (per cent), weight loss (per cent), pH (should be between 3.0 to 4.0), a_w (0.93 to 0.97), yield of the prepared product and organoleptic evaluation. Mass reduction, water loss

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and solid gain were determined as suggested by Rahman and Lamb (7).

Chemical analysis of fresh fruits and hurdle processed products was carried out by the standard methods. Moisture, TSS, pH, ascorbic acid, total carotenoids, total chlorophyll, ash, NEB, total sulphur dioxide and water activity were estimated by the method of Ranganna (8). Total and reducing sugars were estimated by method of Lane and Eynon (6). Total phenols were estimated by the method described in AOAC (2). To evaluate the bitterness in bittergourd, 5 g of dried bittergourd powder was taken in a round-bottomed flask and refluxed for one hour in a water bath with 100 ml methanol. The flask was cooled and the supernatant was decanted and filtered through Whatman filter paper No. 41 and extracted four times with 50 ml methanol each time till the extract became colourless. The extract was then concentrated to a thick extract in 40 ml hot water by shaking in an ultrasonic water bath. This aqueous extract was then filtered and transferred to a 250 ml separating funnel. The residue was washed with 10-50 ml water and then extracted with 50 ml ethyl acetate four times till the ethyl acetate extract became colourless. The ethyl acetate extract was then combined and passed over anhydrous sodium sulphate column. The ethyl acetate extract was evaporated to dryness on a water bath by rotary evaporator in a flat-bottom flask and dried in an oven at 101°C for one hour. The residue was then cooled in a dessicator and weighed (Vidhu, 12).

$$\text{Total bitterness (per cent)} = \frac{\text{Weight of residue}}{\text{Weight of sample}} \times 100 \times \frac{100}{100 - \text{loss on drying}}$$

Antioxidant activity of the sample was estimated using the Ferric reducing antioxidant power (FRAP) assay of Benzie and Strain (3). FRAP values are obtained by comparing the absorbance change at 593 nm in test reaction mixtures with those containing ferrous ions in known concentration. The FRAP value were calculated as;

$$\text{Frap value (µm)} = \frac{DA_{593}\text{ nm test sample} \times \text{FRAP value of standard (µm)}}{DA_{593}\text{ nm standard}}$$

Organoleptic evaluation was conducted on the basis of colour, flavour and texture (Amerine *et al.*, 1) by a panel of seven judges using a nine point Hedonic scale. The overall final rating was obtained by averaging the scores. A score of 5.5 and above was considered acceptable.

RESULTS AND DISCUSSION

Chemical composition of the fresh bitter gourd fruits of cvs. Pusa Hybrid 1 and Pusa Domousmi is as given in Table 5. Fresh fruits of Pusa Hybrid 1 had higher TSS, sugars and acidity than Pusa Domousmi. The yield of the bitter gourd rings was highest (95.02% in Pusa Hybrid 1 and 95.03% in Pusa Domousmi) when 10 per cent salt was used as humectant. Considering

Table 1. Effect of humectants on the product quality of bittergourd rings (cv. Pusa Hybrid 1).

Treatment	Yield of the prepared product (%)	Moisture loss (%)	Ascorbic acid (mg/100 g)	Total chlorophyll (mg/100 g)	Organoleptic evaluation (score)
Salt 10%	95.02	1.12	65.43	0.105	8
Salt 15%	92.84	1.61	62.90	0.105	8
Sugar 15%	85.15	5.14	54.02	0.94	7
Salt 10% + sugar 15%	89.49	4.66	58.62	0.97	7
Salt 10% + sugar 30%	89.22	4.48	47.13	0.88	7
Salt 10% + sugar 45%	89.40	4.81	49.42	0.76	6
Salt 15 % + sugar 15 %	85.88	3.47	52.87	0.50	4
Salt 10 % + sugar 30 %	84.75	5.49	41.38	0.64	5
Salt 15 % + sugar 45 %	86.61	8.48	45.98	0.69	5
Control	88.87	nil	40.30	0.95	7

Table 2. Effect of humectants on the product quality on bitter gourd rings (cv. Pusa Domousmi).

Treatment	Yield of the prepared product (%)	Moisture loss (%)	Ascorbic acid (mg/100g)	Total chlorophyll (mg/100g)	Organoleptic evaluation (score)
Salt 10%	95.03	1.28	69.81	0.103	8
Salt 15%	93.27	2.34	61.79	0.99	8
Sugar 15%	89.06	7.20	58.97	0.98	8
Salt 10% + sugar 15%	87.66	7.08	58.97	0.92	7
Salt 10% + sugar 30%	87.88	6.19	53.84	0.101	8
Salt 10% + sugar 45 %	88.37	4.67	56.41	0.68	6
Salt 15% + sugar 15%	84.81	5.77	61.54	0.68	6
Salt 15% + sugar 30%	84.61	7.00	51.28	0.51	4
Salt 15% + sugar 45%	85.19	6.54	53.84	0.62	5
Control	89.33	Nil	42.56	0.95	6

all the parameters, it was seen that 10 per cent salt was the best humectant for better quality of the product (Tables 1&2). It was seen that among the humectants used individually, bitter gourd rings soaked in sugar underwent maximum osmosis and experienced greater water loss both in Pusa Hybrid 1 (5.14%) and Pusa Domausmi (7.20%), while with salt there was minimum water loss both in *Pusa Hybrid 1* (1.12% with 10% salt and 1.61% with 15% salt) and Pusa Domausmi (1.28% with 10% salt and 2.34% with 15% salt). The combinations of these humectants gave mixed results. The highest total chlorophyll retention was recorded when 10 per cent salt was used as humectant in both Pusa Hybrid 1 (0.105 mg/100 g) and Pusa Domausmi (0.103 mg/100g). This may be due to a lower level of osmosis and probably lesser cell rupture and less damage to cellular components. The highest ascorbic acid content in high moisture bitter gourd rings was also recorded for both the varieties (65.43 mg/100g in Pusa Hybrid 1 and 69.81 mg/100g in Pusa Domausmi) when 10 per cent salt was used as humectant. Among two varieties, retention of ascorbic acid was higher by 3.77 per cent in Pusa Domausmi.

The organoleptic score was 8 when salt at 10 and 15 per cent concentrations was used (Pusa Hybrid 1), whearas Pusa Domausmi samples treated with salt at 10-15 per cent, 15 per cent sugar and 10 per cent salt plus 30 per cent sugar obtained overall organoleptic scores of 8.0. There were differences in the organoleptic quality of the rings of both the varieties soaked at different ratios, so 1:5 was selected as the best soaking ratio due to superior overall organoleptic scores (Tables 1 & 2). The effects of soaking time and temperature of soaking solution on the quality of the products from Pusa Hybrid 1 and Pusa Domausmi are shown in Tables 3 and 4. In both the cases it was observed that the best results on an average were obtained when the soaking temperature was 30°C for different time intervals ranging from 4 to 12 h. However, the soaking time for 12 h was chosen as a longer heat treatment that would present a higher hurdle to microorganisms with no appreciable quality difference.

The data related to the chemical composition of high moisture bitter gourd rings after hurdle processing is presented in Table 5. Hurdle processed bitter gourd rings of Pusa Hybrid-1 showed a higher moisture content (91.20%), TSS (5.2°B), reducing sugars (1.38%), acidity (2.64%) and pH (3.20) as compared to those of Pusa Domausmi, *w*hereas total chlorophyll, ascorbic acid, total sugars, total ash content, total phenols and NEB were more in case of Pusa Domausmi rings after hurdle processing. The loss of ascorbic acid in bitter gourd as a result of blanching and processing was also reported by Kalra *et al.* (5), which ranged from 27.6 to 36.0 per cent in different varieties. The slight decrease in the

Table 3. Effect of soaking time and temperature on the quality of bittergourd rings (cv. Pusa Hybrid 1).

Time		Moisture loss (%)	Yield (%)	TSS (°Brix)	pH	Total chlorophyll (mg/100 g)	Ascorbic acid (mg/100 g)	Organoleptic evaluation (score)
Control (Ambient, 1h)		1.06	95.27	8	5.23	0.105	65.43	8
4 h	30°C	2.16	92.05	3	3.41	0.063	62.41	8
	40°C	2.53	91.60	3	3.44	0.064	53.84	7
	50°C	3.39	90.94	3	3.76	0.053	20.51	5
8 h	30°C	1.68	93.32	3	3.28	0.066	62.92	8
	40°C	2.28	91.83	3	3.43	0.052	56.41	7
	50°C	4.31	88.25	3	3.69	0.061	28.20	6
12 h	30°C	1.24	95.11	3	3.17	0.062	62.48	8
	40°C	2.18	92.54	3	3.36	0.057	58.97	6
	50°C	3.37	89.44	3	3.53	0.052	25.64	5

Table 4. Effect of soaking time and temperature on the quality of bitter gourd rings (cv. Pusa Domousmi).

Time		Moisture loss (%)	Yield (%)	Final TSS (°Brix)	pH	Total chlorophyll (mg/100 g)	Ascorbic acid (mg/100 g)	Organoleptic evaluation (score)
Control (Ambient, 1h)		1.27	95.08	8	5.20	0.103	70.02	8
4 h	30°C	2.21	92.11	3	3.35	0.063	66.54	8
	40°C	2.46	91.52	3	3.36	0.061	58.97	7
	50°C	3.44	90.81	3	3.80	0.052	25.64	5
8 h	30°C	2.08	94.60	3	3.31	0.063	64.36	8
	40°C	2.40	91.42	3	3.40	0.053	53.84	5
	50°C	4.63	87.04	3	3.54	0.053	30.77	5
12 h	30°C	1.40	95.85	3	3.12	0.063	63.05	8
	40°C	2.24	90.49	3	3.32	0.063	58.97	6
	50°C	3.82	88.33	3	3.54	0.053	28.20	5

moisture with a concurrent rise in the TSS in bitter gourd products after processing may be due to the osmotic treatment rendered to them which has drawn out moisture and consequently increased the TSS due to a concentration effect and by solid gain.

The bitterness values for Pusa Hybrid 1 and Pusa Domousmi were 0.0082 and 0.0078 per cent respectively, which showed that retention was higher by 12.32 per cent in Pusa Hybrid 1. The antioxidant activity of bitter gourd rings was higher in Pusa Hybrid 1 (387 µM Fe) than Pusa Domousmi (125 µM Fe), inspite of lower retention of ascorbic acid, total phenols and total chlorophyll in Pusa Hybrid 1 compared to Pusa Domousmi. The sulphur dioxide retention in hurdle processed rings of Pusa Hybrid 1 and Pusa Domousmi was 65.60 and 66.13 per cent, respectively. The organoleptic scores out of scale 9 for hurdle processed rings for both the varieties was 8.1.

In general, there was an increase in TSS, acidity, reducing sugars, total sugars and a decrease in moisture, pH, ascorbic acid, bitterness, antioxidant acidity, phenols of bitter gourd products by hurdle technique. Vijayanand *et al.* (13) reported similar trends with respect to TSS, pH, acidity and moisture in pineapple, mango and papaya chunks preserved by hurdle technology. Hurdle processing due to its sheer simplicity and effectiveness can serve as a powerful tool for processing. It has great potential for domestic and export markets for value added products that can ensure nutritional and food security.

Table 5. Chemical composition of fresh and hurdle processed bitter gourd rings.

Parameter	Pusa Hybrid 1		Pusa Domousmi	
	Fresh	Hurdle processed	Fresh	Hurdle Processed
Moisture (%)	92.4	91.20	92.3	90.90
TSS (°Brix)	3.0	5.2	2.9	5.1
Acidity (%)	0.2	2.64	0.18	2.6
pH	4.20	3.2	4.54	3.04
Reducing sugars (%)	1.12	1.38	1.08	1.30
Total sugars (%)	1.84	2.39	1.80	2.42
Ascorbic acid (mg/ 100 g)	82.05	63.08	84.36	66.10
Total chlorophyll (mg/100 g)	0.116	0.072	0.118	0.076
Total ash (%)	1.30	1.22	1.47	1.47
Total phenols (mg/ 100 g)	62.8	22.56	64	23.12
Bitterness (%)	0.0117	0.0082	0.0125	0.0078
Antioxidant activity (µM Fe II)	508	387	247	125
Non enzymatic browning (OD at 420 nm)	-	0.660	-	0.700

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