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RESEARCH PAPER

Development and Quality Evaluation of Bitter gourd- Kiwi Blended Squash during Storage

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ABSTRACT

Bitter gourd fruit (*Momordica charantia* L.) contains many nutraceutical compounds and possess antioxidant and hypoglycemic activity but, its utilization in foods products has not received much attention. Efforts were made to prepare antioxidant rich palatable bitter gourd based functional squash by blending bitter gourd juice with kiwi fruit (*Actinidia deliciosa)* juice in different ratios viz. 90:10, 80:20, 70:30, 60:40 and 50:50 using different levels of fruit part (25, 30 and 35%) and TSS (40 and 45°B) separately. Among different combinations, the squash prepared using 30% blended juice of treatment T_{32} (80% bitter gourd juice+20% *kiwi* juice) with 45°B TSS recorded highest sensory scores. The developed products were analyzed for their bio-chemical, antioxidant potential and sensory quality characteristics at different storage intervals (0,3 and 6 months). The bitter gourd- kiwi blended squash contained 44.83°B TSS, 1.25% acidity and 37.54% total sugars. Blending has increased ascorbic acid content (33%) and total phenolics (24%) of the blended beverage over bitter gourd squash. The products exhibited only slight changes in their physico-chemical, nutritional and sensory characteristics during storage, yet were shelf-stable and remained acceptable up to a period of six months. The high antioxidant potential (68.29%) of the developed product compared to the control sample revealed its health benefits.

Keywords: Bitter gourd, *Momordica charantia* L., functional beverages, kiwi, blending, antioxidant, storage

Fruits and vegetables are important constituents of the diet because they provide a significant amount of nutrients, especially vitamins, sugars, minerals and fibers. Fruit and vegetable based beverages have higher nutritional, medicinal and calorific values than synthetic beverages (Bhardwaj and Shruti, 2011). However, owing to high acidity, astringency and bitterness in some of the fruits and vegetables, their utilization for the preparation of various processed products becomes limited, in spite of having high nutritional value. Therefore, blending of two or more fruit and vegetable juices for the preparation of beverages may be a simple, economical and practical approach for the utilization of these fruits and vegetables. Bitter gourd (*Momordica charantia* L.) is the one of such commodities which is known to be a good source of vitamin C, phosphorus and iron while a poor source of sugar. It has been reported to be anti-diabetic, stimulant, stomachic, laxative, blood purifier, contains many nutraceutical compounds and possess antioxidant and hypoglycemic activity (Anilakumar *et al*., 2015). In spite of the tremendous nutritive and medicinal properties, its utilization in beverage preparation has not received much

attention possibly due to its bitter taste (Sharma and Tondon, 2015). Thus, blending seems to be an effective alternative. Kiwi (*Actinidia deliciosa*) which is known for its high nutritive and medicinal values contained a significant amount of biologically active compounds, including ascorbic acid, carotenoids and phenolics. Keeping these points in view, the present study was attempted for the production of delightful and delicious beverage with improved sensory and nutritive values by blending bitter gourd juice with kiwi fruit.

MATERIALS AND METHODS

Procurement of raw materials

Fresh and mature fruits of bitter gourd (*Momordica charantia L.*) cv. Solan Hara were procured from the local fruit and vegetable market, Solan (HP) and brought immediately to the fruit processing unit of Department of Food Science and Technology Dr YS Parmar University of Horticulture and Forestry Nauni, Solan (HP) for the further studies, whereas, Kiwifruits (*Actinidia deliciosa*) cv. Bruno were procured from the Kiwi Orchard, Department of Fruit Science, Dr YS Parmar University of Horticulture and Forestry, Nauni Solan (HP).

Extraction of juice/pulp from bitter gourd and kiwifruit

Bitter gourd fruits (cv *Solan Hara*) were sorted, washed thoroughly with water, cut into pieces and the juice was extracted in a hydraulic press after grating the pieces. The extracted juice was heat preserved in glass bottles after lowering the pH to 3.5-4.0 by adding citric acid (Sharma and Tandon, 2015). The pulp of kiwi fruits (cv *Bruno)* was extracted by hot break pulping method followed by preservation with SO_2 @ 1000 ppm and storing at refrigerated temperature (4-7^{o}C) for later use.

Blending of bitter gourd juice and kiwifruit pulp to develop nutritious beverage

Different combinations of bitter gourd juice and kiwi pulp were tried for optimization of a suitable combination for the preparation of palatable bitter gourd based functional squash as detailed in Table 1. The beverages were prepared as per standard method and specifications of FSSA-2006 using 25, 30 and 35 per cent fruit part (blended), maintaining TSS and acidity between 40-45^{o}B and 1.2-1.3 per cent, respectively in all the treatments. Best combination/ blend was selected on the basis of sensory evaluation.

Analyses

Physico-chemical and sensory analysis: All the beverages were analysed for their physico-chemical characteristics viz. TSS, titratable acidity, total sugars, reducing sugars, total phenols and ascorbic acid as per standard analytical methods prior to and during storage (Ranganna, 1986). The sensory evaluation of the products was conducted by a panel of 15 semi-trained judges using 9- point hedonic scale system for different parameters like appearance, body, flavor, bitterness, acceptability and overall acceptability. The samples were presented in random order and the judges were asked to score the samples on 9-point hedonic scale with a maximum score of 9 for "*like extremely*" and minimum of 1 for "*dislike extremely*" as per the procedure described by Joshi (2006).

***Antimicrobial and antioxidant activity*:** The antimicrobial activity of the developed beverages against *E. coli* and S. *aureus* was measured by well diffusion method as described earlier (Aneja, 2003). The inoculum was spread with the help of swab uniformly on the plate and a standard cork borer of 7 mm diameter was used to cut uniform wells on the surface of solid medium. In each well, 100 µl of sample was loaded and the plates were then, incubated at 37 ºC for 24 hrs. The antimicrobial activity was expressed in terms of mean diameter of the zones of inhibition measured. The antioxidant activity (Free radical scavenging activity) was measured as per the method of Brand -Williams *et al*. (1995) where DPPH (2, 2 diphenyl-1-picrylhydrazyl) was used as a source of free radical. A quantity of 3.9 ml of 6×10^{-5} mol/L DPPH in methanol was put into cuvette with 0.1 ml of sample extract and decrease in absorbance was measured at 515 nm for 30 min or

until the absorbance becomes steady, using methanol as a blank. The per cent antioxidant activity was calculated using the following equation:

$$\text{Antioxidant Activity (\%)} = \frac{Ab_{(B)} - Ab_{(S)}}{Ab_{(B)}} \times 100$$

Where, $Ab_{(B)}$ = Absorbance of Blank; $Ab_{(S)}$ = Absorbance of sample

Statistical Analysis. All the analytical parameters were recorded in triplicates and the mean values of each parameter were described. The data of quantitative estimation of biochemical characteristics were assessed by factorial CRD whereas the data pertaining to sensory evaluation were analyzed by RBD as described by Cochran and Cox (1967).

Table 1: Detail of treatments for the preparation of bitter gourd-kiwi blended functional squash

Treatments	Bitter gourd juice (%)	Kiwi juice (%)	Fruit Part (blend) (%)	TSS (°B)
$T_1 (B_{100}: K_0)$	100	—	25	40
$T_2 (B_{90}:K_{10})$	90	10	30	40
$T_3 (B_{90}:K_{10})$	90	10	30	45
$T_4 (B_{90}:K_{10})$	90	10	35	40
$T_5 (B_{90}:K_{10})$	90	10	35	45
$T_6 (B_{80}:K_{20})$	80	20	30	40
$T_7 (B_{80}:K_{20})$	80	20	30	45
$T_8 (B_{80}:K_{20})$	80	20	35	40
$T_9 (B_{80}:K_{20})$	80	20	35	45
$T_{10} (B_{70}:K_{30})$	70	30	30	40
$T_{11} (B_{70}:K_{30})$	70	30	30	45
$T_{12} (B_{70}:K_{30})$	70	30	35	40
$T_{13} (B_{70}:K_{30})$	70	30	35	45
$T_{14} (B_{60}:K_{40})$	60	40	30	40
$T_{15} (B_{60}:K_{40})$	60	40	30	45
$T_{16} (B_{60}:K_{40})$	60	40	35	40
$T_{17} (B_{60}:K_{40})$	60	40	35	45
$T_{18} (B_{50}:K_{50})$	50	50	30	40
$T_{19} (B_{50}:K_{50})$	50	50	30	45
$T_{20} (B_{50}:K_{50})$	50	50	35	40
$T_{21} (B_{50}:K_{50})$	50	50	35	45

RESULTS AND DISCUSSION

The bitter gourd juice and kiwi juice/pulp were analyzed for various physico-chemical parameters (Table 2). It is apparent from the data that bitter gourd juice contained very low sugar and titratable acidity (as % citric acid) but considerable amount of ascorbic acid (82.08 mg/100g), and a very low pH (Table 2). The results were closer to Satkar *et al*. (2013) and Kaur and Aggarwal (2014). The total phenolic contents and antioxidant activity in bitter gourd juice were observed as 21.99 mg/100g and 68.86 per cent, respectively and were in conformity with those of Kaur and Aggarwal (2014).

Table 2: Physico-chemical characteristics of fresh bitter gourd and kiwifruit juice/pulp

Parameters*	Bitter gourd juice (Mean ± SD)	Kiwifruit pulp (Mean ± SD)
TSS (^{0}B)	5.50 ± 0.50	12.45± 1.00
Titratable acidity (%)	0.29 ± 0.01	1.74 ± 0.04
pH	3.75 ± 0.05	2.97 ± 0.04
Ascorbic acid (mg/100g)	82.08 ± 1.52	101.95 ± 3.03
Reducing sugars (%)	0.61 ± 0.08	3.58 ± 0.12
Total sugars (%)	1.93 ± 0.05	7.67 ± 0.22
Total phenolics (mg/100g)	21.99 ± 0.89	131.66 ± 3.78
Antioxidants potential (% free radical scavenging activity)	68.86 ± 1.23	68.98 ± 0.93

*Each value is average of 3 determinations; SD = Standard Deviation

Further, kiwifruit pulp proved to be good source of sugars and ascorbic acid with quit high acidity and low pH. In the literature, kiwifruit pulp was found to contain 12.40-13.10^{o}B TSS, 1.68-1.80 per cent titratable acidity, 3.20-3.30 pH and 121.00-135.00 mg/100g ascorbic acid (Thakur and Barwal, 1988; Leahu *et al*., 2013). The reducing sugars and total sugars were recorded as 3.58 per cent and 7.67 per cent, respectively which were lower than the findings

of Sharma *et al*. (2013). Total phenolic contents were found to be 131.66 mg/100g, while the antioxidant potential was observed to be 68.98 per cent. These findings were in the range of Park *et al*. (2006). The pulp recovery of 60.67 per cent was recorded which was closer to the findings of Vaidya *et al*. (2009).

Optimization of best combination

Evaluation of sensory attributes of the developed squash (Fig. 1) showed that with the increase in the proportion of kiwi pulp up to 20 per cent, the score for colour and body increased, beyond which these decreased consistently. The scores of body apparently decreased due to cloudy appearance of the beverage while the score for bitterness acceptability increased gradually with the increase in proportion of kiwi pulp. The same was the case with taste score except at higher levels of kiwi pulp (≥40%), the taste score decreased. It might be due to astringent taste of kiwi at higher level of pulp. Results are in conformity with earlier studies conducted by Kausar *et al*. (2012) and Raj (2013) in cucumber-melon functional drink and sand pear-apple juice beverage. Among the different combinations tried, the treatment T_7 (80% bitter gourd juice + 20% kiwi pulp) with 30% fruit part and 45° B TSS was adjudged as the best in all the sensory attributes.

Physico-chemical, nutritional and sensory characteristics

A comparison of data (Table 3) revealed that the addition of kiwi pulp has improved the nutritional quality of the squash as is evident from its higher ascorbic acid (27.15 mg/100g) and total phenolics (25.22 mg/100g) compared to the standard bitter gourd squash (18.25 mg/100g and 19.44 mg/100g), respectively.

The blended squash had higher antioxidant potential (68.29%) and strong antimicrobial activity (Fig. 2 & 3) against *S. aureus* (18.00 mm inhibition zone) as well as *E. coli* (16.00 mm inhibition zone). Further, the blending has also exerted positive effect on sensory attributes of the beverages as the blended squash had recorded higher score for appearance (7.40), body (8.00), flavour (7.80), bitterness acceptability (7.90) and overall acceptability (8.00) compared to bitter gourd squash (Fig. 4). Earlier, many workers have reported that two or more fruit pulp/juices blended in various proportions for making more palatable and nutritious beverages (Raj, 2013; Mohamed *et al*., 2014; Sheela and Shruthi, 2014)

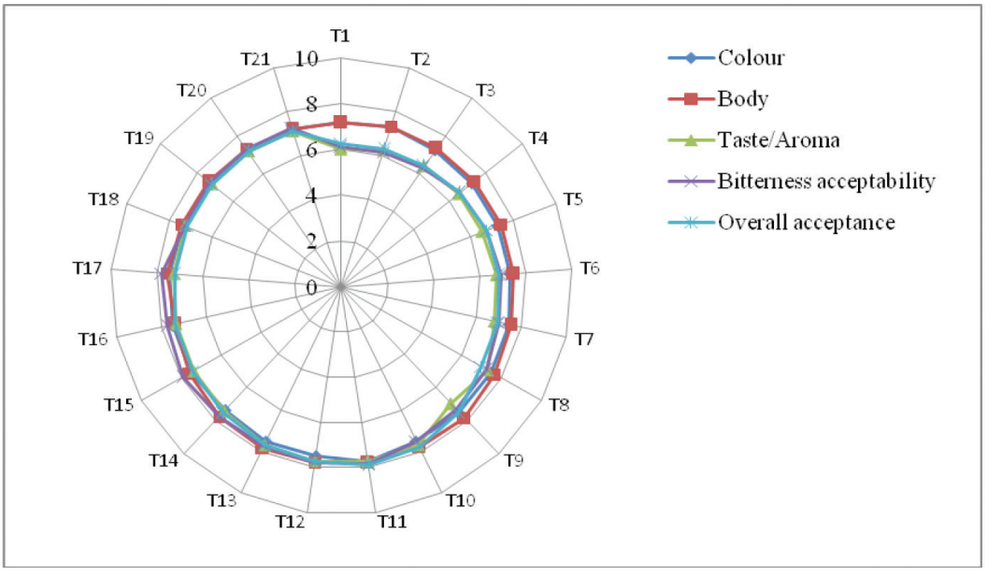

Fig. 1: Sensory attributes of bitter gourd squash and bitter gourd: kiwi blended squash

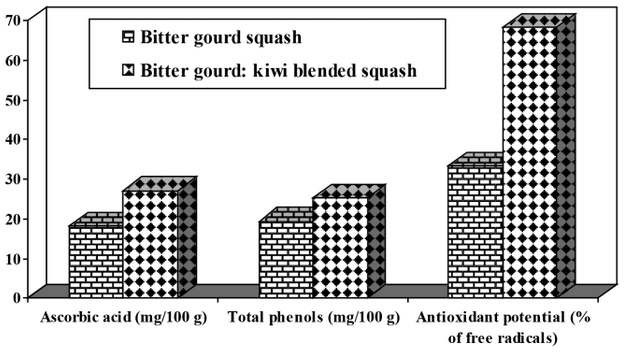

Fig. 2: Nutritive and antioxidant potential of bitter gourd and bitter gourd: kiwi blended squash

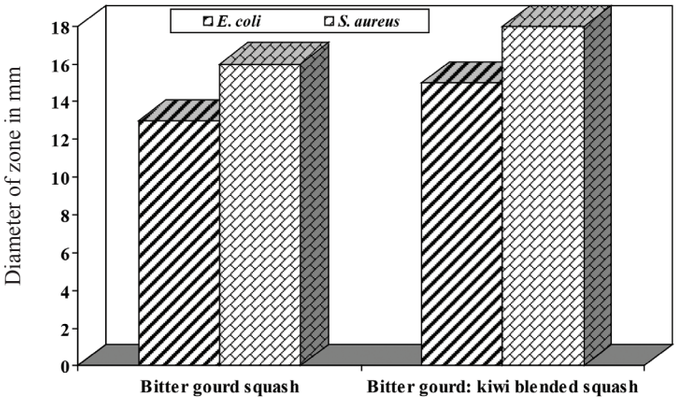

Fig. 3: Antimicrobial activity of bitter gourd and bitter gourd: kiwi blended squash

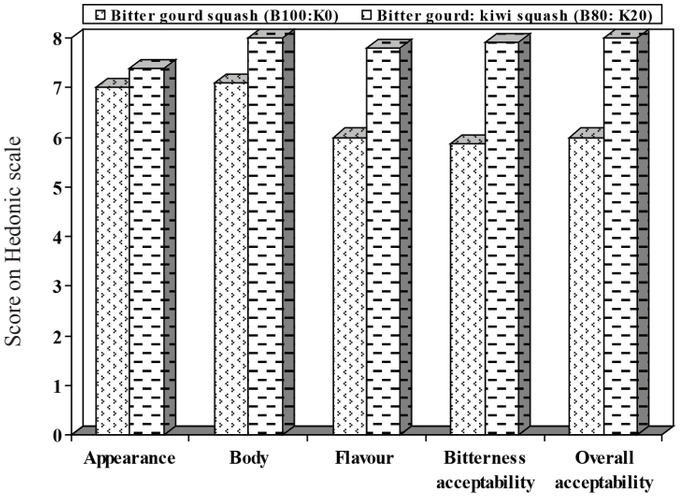

Fig. 4: Sensory attributes of bitter gourd squash and bitter gourd: kiwi blended squash

Table 3: Comparison of physico-chemical, nutritional and sensory characteristics of bitter gourd squash and bitter gourd: kiwi blended squash

Parameters	Mean ±SD	
	Bitter gourd squash (B_{100}:K_0; F_{25}:T_{40})	Bitter gourd: kiwi squash (B_{80}:K_{20}; F_{30}:T_{45})
TSS (^{0}Brix)	40.00 ± 0.99	44.83 ± 1.00
Titratable acidity (%)	1.20 ± 0.05	1.25 ± 0.05
pH	2.70 ± 0.05	2.68 ± 0.05
Ascorbic acid (mg/100g)	18.25 ± 0.50	27.15 ± 0.55
Reducing sugars (%)	21.71 ± 0.65	21.86 ± 0.65
Total sugars (%)	36.25 ± 0.85	37.54 ± 0.95
Total phenolics (mg/100g)	19.44 ± 0.50	25.22 ± 0.60
Antioxidants potential (% free radical scavenging activity)	33.32 ± 0.75	68.29 ± 1.23

SD = Standard Deviation

Effect of storage on bitter gourd-kiwi blended squash

Data (Table 4) showed that TSS content increased non-significantly during 6 months of storage period which could be due to hydrolysis of polysaccharides into monosaccharide and oligosaccharides during storage as reported earlier by Deka and Sethi (2001) in juice blends. A slight but statistically non-significant decrease in titratable acidity was observed during storage, which might be due to co-polymerization of organic acids with sugars and amino acids and loss of volatile acid during storage (Barwal *et al*., 2005). Similar results were also reported by Tiwari (2000) in guava and papaya blended RTS and Dhaliwal and Hira (2001) in carrot juice blends. A significant decrease in ascorbic acid took place during storage in various treatments which could be due to oxidation of ascorbic acid into dehydro-ascorbic acid, furfural and hydroxyl furfural and thermal degradation (Aruna *et al*., 1997; Mandal and Nath, 2013 and Karpagavalli and Amutha, 2015). The reducing sugars increased non-significantly during storage (Table 5) apparently due to inversion of non-reducing sugars to reducing sugars under acidic conditions, which correlates with the findings of Sahni and Khurdiya (1989). The total sugar decreased during storage period of 6 months. The marginal decrease in total sugars may be attributed to the hydrolysis of insoluble polysaccharides and other carbohydrate polymers at higher temperature (Narayana *et al*., 1996) and the results are in conformity with those of Shivkumar *et al*. (2009) and Karpagavalli and Amutha (2015). A significant decrease in phenolic contents (Table 5) took place during storage in all the treatments (22.33 mg/100g to 17.34 mg/100 g). The decrease in the total phenolic contents of squash during storage might be due to their involvement in the formation of polymeric compounds by complexing with protein and their subsequent precipitations as has also been observed by Abers and Wrolstad., (1979); Kannan and Thirumaran., (2001).

The mean organoleptic sensory scores (Table 6) of bitter gourd- kiwi blended squash revealed that appearance, flavour, bitterness acceptability and overall acceptabilty scores of squash, decreased with the advancement of storage period. Decrease in appearance score during storage might be due to co-polymerization, interaction between phenolics, degradation of colloidal particles and protein as well as the formation of cataion complexes with pectins and phenolics during storage (Wilson and Burns., 1983). Among different treatments, the highest value for flavor/ taste was awarded to the treatment T_1 (7.75). During storage, the flavour score decreased non-significantly which might be attributed to the possible loss of volatile aromatic substances during storage at ambient condition as has also been reported by Thakur and Barwal (1998). The score for bitterness acceptability decreased non-significantly with advancement in storage period. However, a slight decrease in bitterness acceptability score of

Table 4: Effect of treatments and storage period on TSS, Titratable acidity and ascorbic acid of the bitter gourd: kiwi blended squash

Treatments	TSS (^{0}B)				Titratable Acidity (%)				Ascorbic Acid (mg/100g)			
	Storage Period, Months											
	0	3	6	Mean (T)	0	3	6	Mean (T)	0	3	6	Mean (T)
T_1	40.00	40.16	40.31	40.16	1.20	1.16	1.10	1.15	18.25	16.32	14.28	16.28
T_2	44.83	45.03	45.15	45.00	1.25	1.20	1.14	1.19	27.15	24.25	22.52	24.64
Mean (S)	42.42	42.60	42.73		1.22	1.18	1.12		22.70	20.28	18.40	
$CD_{0.05}$												
Treatment (T)				0.52				NS				0.31
Storage (S)				NS				NS				0.38
T × S				NS				NS				0.53

T_1 = 100 % bitter gourd squash; T_2=80 % bitter gourd + 20 % kiwi juice blended squash; NS =Non significant

Table 5: Effect of treatments and storage period on reducing sugars, total sugars and phenolic content of the bitter gourd: kiwi blended squash

Treatments	Reducing Sugars (%)				Total Sugars (%)				Phenolics (mg/100g)			
	Storage Period , Months											
	0	3	6	Mean (T)	0	3	6	Mean (T)	0	3	6	Mean (T)
T_1	21.71	21.78	21.85	21.78	36.25	36.18	36.20	36.21	19.44	16.32	14.52	16.76
T_2	21.86	21.90	21.96	21.91	37.54	37.50	37.43	37.49	25.22	22.68	20.16	22.68
Mean (S)	21.79	21.84	21.91		36.89	36.84	36.82		22.33	19.49	17.34	
$CD_{0.05}$												
Treatment (T)				NS				0.28				0.22
Storage (S)				NS				NS				0.26
T x S				NS				NS				0.38

T_1 = 100 % bitter gourd squash; T_2=80 % bitter gourd + 20 % kiwi juice blended squash; NS =Non significant

Table 6: Effect of treatments and storage period on sensory quality* of the bitter gourd : kiwi blended squash

Treatments	Appearance				Flavour				Bitterness acceptability				Overall acceptability			
	Storage Period, Months															
	0	3	6	Mean (T)	0	3	6	Mean (T)	0	3	6	Mean (T)	0	3	6	Mean (T)
T_1	7.09	7.06	7.00	7.05	6.00	5.96	5.92	5.96	6.00	5.95	5.93	5.96	6.10	6.05	6.00	6.05
T_2	7.90	7.87	7.83	7.86	7.75	7.72	7.70	7.72	7.90	7.85	7.82	7.86	7.95	7.92	7.88	7.92
Mean (S)	7.49	7.46	7.42		6.87	6.84	6.81		6.95	6.90	6.88		7.02	6.98	6.94	
$CD_{0.05}$																
Treatment (T)				0.14				0.25				0.14				0.06
Storage (S)				NS				NS				NS				NS
T x S				NS				NS				NS				NS

* Sensory evaluation on 9- point Hedonic scale; T_1 = 100 % bitter gourd squash; T_2 =80 % bitter gourd + 20 % kiwi juice blended squash; NS =Non significant

the beverages might be due to loss of flavour during storage. The overall acceptability score of the squash experienced a slight decrease with increase in storage period. The loss of appearance and flavour score of the beverages during storage might have contributed decline in overall acceptability scores (Singh and Singh, 2014). Besides these slight changes in sensory characteristics, the developed beverage remained acceptable (≥ 7.00 score) even after six months of storage at ambient temperature.

CONCLUSION

It can be concluded that blending bitter gourd juice with kiwi had improved both in sensory and nutritional characteristics of the beverage. Among different blended ratio, the ratios of 80:20 (T_7= 80% bitter gourd juice +20% *kiwi* pulp) with 30% fruit part and 45° B TSS had recorded highest sensory scores for taste, bitterness acceptability and overall acceptability. The blended squash contained higher amounts of ascorbic acid, total penolics and had also shown higher antioxidant as well as antimicrobial activity compared to the control sample (bitter gourd squash). On the basis of the results revealed in the present study, it is concluded that the formulation of bitter gourd: kiwi blended squash is possible to satisfy consumer taste and preferences. These type of squashes can be stored effectively for a period of 6 months at room temperature. Hence, their availability in the market will definitely benefit the health conscious people.

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