International Journal of Farm Sciences **5(1)** : 68-77, 2015

Development and evaluation of antioxidant rich low calorie functional bitter gourd (*Memordica charantia* L) spiced squash

RAKESH SHARMA and D TANDON

Department of Food Science and Technology
***Department of Basic Sciences**
Dr YS Parmar University of Horticulture and Forestry
Nauni, Solan 173230 HP, India
Email for correspondence: drrakes@gmail.com

ABSTRACT

Efforts were made to develop antioxidant rich bitter gourd based functional spiced squash through fortification with ascorbic acid and using stevioside sweetness at different proportions (25, 50, 75 and 100%). Out of different combinations tried a combination of 27.5 per cent juice, 45.00°B TSS, SE_2 spice recipe (10.0 g common salt, 15.0 g black salt, 8.0 g cumin, 3.0 g cardamom, 8.0 g black pepper and 40.0 ml ginger extract) with ascorbic acid (0.5%) was found the best. A good amount of ascorbic acid (390.36 to 425.85 mg/100 g) was recorded in bitter gourd based functional spiced squash. Sensory analysis indicated highest acceptability for stevia sweetened (75% stevioside sweetness) squash followed by those sweetened with 50 per cent stevioside sweetness. The developed product was found to have strong antimicrobial activity (28 mm inhibition zone) against *Escherichia coli* as well as high antioxidant potential (83.33%). The calculated energy value of the developed product was recorded to be 44.5 Kcal/100 g which was significantly low compared to the control sample (153.5 Kcal/100 g).

Keywords: Bitter gourd; stevia; non-nutritive sweeteners; spiced squash; vitamin C

INTRODUCTION

Bitter gourd (*Memordica charantia* L) is known to be a good source of vitamin C, phosphorous and iron while poor source of sugar (Kalra et al 1988). It is anti-diabetic, stimulant, stomachic, laxative, blood purifier and has been reported to contain many nutraceutical compounds and possesses antioxidant and hypoglycemic activity (Raman and Lau 1996, Horax et al 2005). Despite these tremendous nutritive and medicinal properties its utilization in food products has not received much attention due to some inherent problems like bitter taste. Spiced squash is a type of fruit beverage similar to squash in which extract of spices and herbs is used primarily for their strong flavor, aroma and natural antioxidants

(Barwal and Sharma 2001). In the recent years fruit beverages are gaining popularity among the masses. But these are generally found to be concentrated source of sugar which provide quick burst of energy and large amount of calories. Unfortunately excess calorie intake is partially responsible for hypertension, cardiovascular diseases, increased incidence of diabetes mellitus and obesity (Moczara et al 2012). Functional beverages are the drinks which are altered in such a way so as to provide specific health benefits and disease preventing properties beyond general nutrition (Sharma et al 2013). Therefore availability of functional beverages with reduced calorie value can play an important role in health promotion and prevention of such diseases. One of the alternatives for development of such functional beverages seems to replace bulk caloric sweeteners with high intensity non-nutritive sweeteners (Verdi and Hood 1993). Non-nutritive sweeteners have a sweet taste but are effectively non-caloric (Pandey and Nigam 1987). Stevia is one such sweetener which has been suggested for use in dietetic foods especially for diabetics (Kumar et al 2007). Various works have also reported its use in the treatment of diseases like diabetes, high blood pressure and obesity in various traditional systems of medicine (Sumathi et al 2005, Joshi et al 2006). Though some work on the utilization of bitter gourd for preparation of beverages has been reported in the literature by Din et al (2011), Barwal et al (2005), Singh and Gaikwad (2012) and Satkar et al (2013) but no work has so far been reported on development of stevia sweetened bitter gourd based vitamin C enriched low calorie spiced beverages. The present study was undertaken to develop bitter gourd based functional spiced squash using stevia with reduced calorie and high antioxidant potential for the benefit of masses in general and health conscious people in particular.

MATERIAL and METHODS

Raw material

Bitter gourd fruits cv Solan Hara were purchased from local market, Solan, HP. Fruits were sorted, washed thoroughly with water, cut into pieces and the juice was extracted in hydraulic press after grating the pieces followed by preservation with SO_2 @1000 ppm and citric acid @ 0.3 per cent in glass bottle for further use. All the spices such as cardamom, cumin, black pepper and black salt were used in powdered form. Fresh ginger juice was extracted through a screw type juice extractor. The commercial grade ascorbic acid was purchased from M/s HPMC Jabli, Solan, HP whereas stevioside powder was procured from the Department of Forest Products and Utilization, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, HP.

Preparation of standard as well as low calorie bitter gourd spiced squash

Different combinations of bitter gourd juice (25, 27.5 and 30%), TSS (40 and 45°B), spices extract (SE_1 and SE_2) with

addition of ascorbic acid (0.5%) were tried for optimization of a suitable combination for the preparation of palatable standard bitter gourd spiced squash (Table 1). The products were prepared according to method standardized by Barwal and Sharma (2001). The best combination was selected on the basis of sensory evaluation for the development of low calorie appetizer. The low calorie bitter gourd spiced squash was prepared by replacing sugar sweetness with equi-sweetness of stevioside at different proportions (Table 2) as per the method given by Sharma et al (2013).

Physico-chemical, sensory and statistical analysis

All the beverages were evaluated for their physico-chemical characteristics viz TSS, titratable acidity, pH, total sugars, total phenols, salt (as NaCl) and ascorbic acid as per standard methods (Ranganna 1986). Energy value of the appetizer was calculated by taking into account the amount of sugars, proteins and fat content present in the appetizer. The contents of each nutrient were multiplied by conversion factor as reported by Kalia and Sood (1996). Sensory evaluation of the product was conducted by a panel of 15 semi-trained judges using 9-point hedonic scale system for different parameters like appearance, flavor, taste and overall acceptability (Amerine et al 1965). Antimicrobial activity against *Escherichia coli* procured from Indira Gandhi Medical College, Shimla, HP was measured by well diffusion method (Aneja 2003) and was expressed in terms of mean diameter (mm) of the zones of inhibition measured. 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.

All the analytical parameters were recorded in triplicate and the mean values of each parameter were described. The data of quantitative estimation of physico-chemical characteristics were assessed by factorial CRD. However data pertaining to sensory evaluation were analyzed by RBD as described by Cochran and Cox (1967).

RESULTS and DISCUSSION

Sensory quality of ascorbic acid fortified bitter gourd standard spiced squash

For optimization of palatable recipe the bitter gourd spiced squash was analyzed for various sensory attributes which are presented in Fig 1. The appearance score which reflects the colour as well as body of the beverages ranged from 7.10 to 7.75 with maximum obtained by the treatment T_8 that was statistically at par with T_9 ($p < 0.05$). The highest taste score (8.15) was recorded in treatment T_9 and minimum score (6.00) in T_{10} whereas the flavour score among different treatments ranged from 6.50 to 7.15. It was found that the

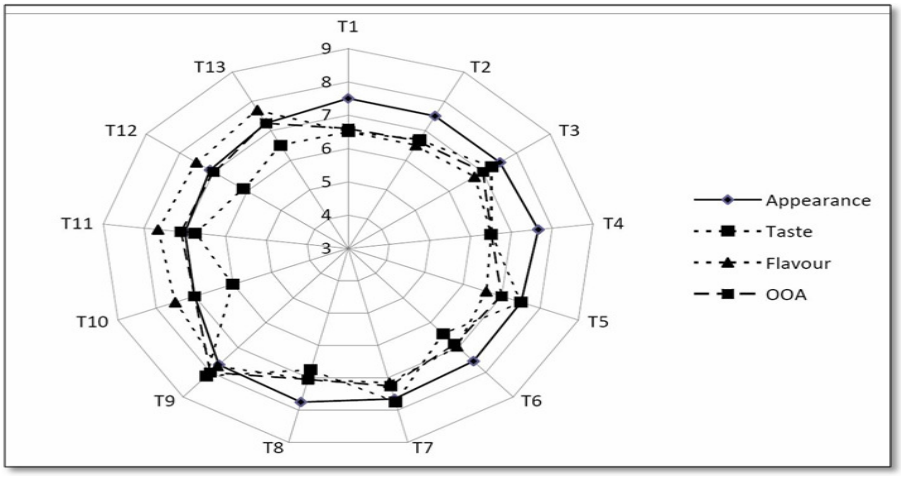

Fig 1. Sensory evaluation of ascorbic acid fortified bitter gourd spiced squash

spiced squash prepared with spice recipe (SE_2) with higher TSS of 45°B scored relatively better sensory score for taste and flavour which might be due to the fact that strong flavour of spices especially ginger along with higher sweetening taste masked the bitter taste of bitter gourd. Similar observations were also reported by various workers while preparing spiced beverages (Lal et al 1999, Barwal and Sharma 2001). The highest overall acceptability score (8.00) was obtained by the spiced squash prepared with 27.5 per cent juice, 45° B TSS, spice extract SE_2 and 0.5 per cent ascorbic acid (T_9) which differed significantly with rest of the treatments (Fig 1). The treatment T_9 was adjudged the best by the panelists due to its acceptable sugar/acid blend. According to Sharma et al (2013) addition of spices, herbs and salt might have influenced the taste perception of the judges. Hence based on sensory evaluation treatment T_9 was selected for further studies for preparation of low calorie bitter gourd appetizer.

Physico-chemical and sensory analysis of low calorie bitter gourd spiced squash

Table 3 reveals the data pertaining to physico-chemical composition of low calorie bitter gourd spiced squash. Highest TSS of 44.5°B was recorded in standard appetizer T_1 (100% sucrose) that differed significantly from rest of the treatments whereas lowest TSS of 6.20°B was recorded in T_5 (100% stevioside). It is reported that high intensity alternative sweeteners like saccharin, cyclamate, aspartame, stevioside do not add to the TSS (Pandey and Nigam 1987, Barwal et al 2005, Kumar et al 2007). The titratable acidity (%) as well as pH remained non-significant for all the treatments due to the

Table1. Ingredients used for preparation of standard bitter gourd spiced squash (1L)

Treatment	Juice (%)	TSS (°Brix)	Spice extract (SE)#
T_1 (control)	25.0	40.0	SE_1 (without antioxidant)*
T_2	25.0	40.0	SE_1
T_3	25.0	40.0	SE_2
T_4	25.0	45.0	SE_1
T_5	25.0	45.0	SE_2
T_6	27.5	40.0	SE_1
T_7	27.5	40.0	SE_2
T_8	27.5	45.0	SE_1
T_9	27.5	45.0	SE_2
T_{10}	30.0	40.0	SE_1
T_{11}	30.0	40.0	SE_2
T_{12}	30.0	45.0	SE_1
T_{13}	30.0	45.0	SE_2

#SE_1= 10.0 g common salt, 15.0 g black salt, 5.0 g cumin, 3.0 g cardamom, 5.0 g black pepper and 20.0 ml ginger extract; SE_2= 10.0 g common salt, 15.0 g black salt, 8.0 g cumin, 3.0 g cardamom, 8.0 g black pepper and 40.0 ml ginger extract

*Ascorbic acid @ 0.5% was added as an antioxidant in all the treatments except T_1 (control)

Table 2. Experimental detail for the preparation of low calorie bitter gourd appetizer using stevioside

Treatment	Per cent sweetness equivalent used#	
	Sucrose	Non-nutritive sweeteners (stevioside)
LT_1 (standard)	100	0
LT_2	75	25
LT_3	50	50
LT_4	25	75
LT_5	0	100

The sweetness potential of stevioside was worked out to be 250 times than sucrose

Table 3. Physico-chemical and sensory characteristics of ascorbic acid fortified low calorie bitter gourd spiced squash

Treatment	LT_1 (standard)	LT_2 (75+25)	LT_3 (50+50)	LT_4 (25+75)	LT_5 (100)	$CD_{0.05}$
Physico-chemical parameters						
TSS (°Brix)	44.50	35.75	21.85	16.50	6.20	0.25
Titratable Acidity (%)	1.03	1.02	0.98	1.02	0.96	NS
pH	2.75	2.75	2.80	2.78	2.80	NS
Reducing Sugars (%)	22.44	16.35	7.89	6.82	1.60	0.34
Total sugars (%)	36.87	25.96	13.45	10.05	3.94	0.18
Ascorbic acid (mg/100g)	395.26	415.75	398.35	410.56	425.85	NS
Total phenols (mg/100g)	103.88	102.75	105.76	104.14	108.31	NS
Salt (Nacl %)	1.60	1.63	1.58	1.63	1.60	NS
Sensory parameters#						
Appearance	7.60	7.65	7.60	7.60	7.50	NS
Taste	7.70	7.65	7.75	8.00	7.60	0.12
Flavour	8.00	7.75	8.00	8.00	7.75	0.08
Overall acceptability	7.70	7.65	7.75	8.00	7.45	0.10

#Sensory evaluation on 9-point hedonic scale, 9= Like extremely, 1= Dislike extremely

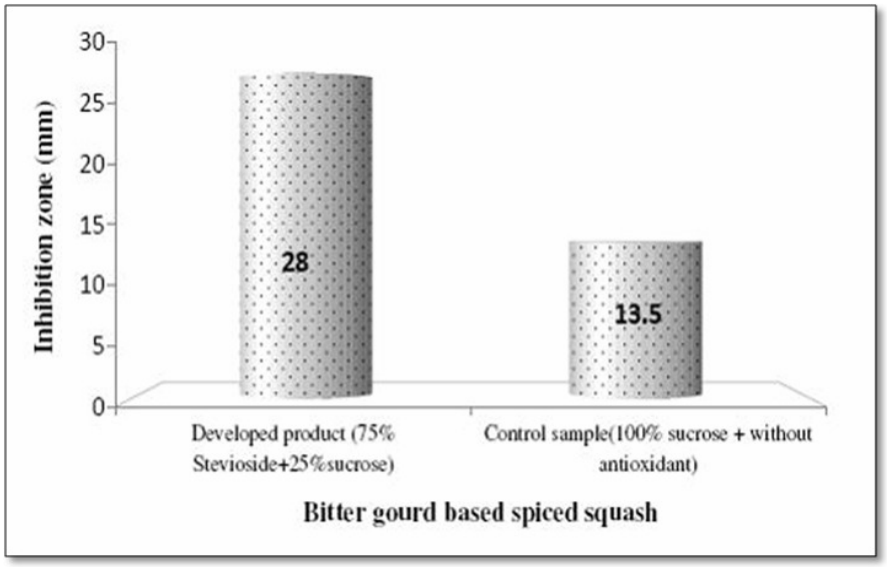

Fig 2. Antimicrobial activity of ascorbic acid fortified low calorie bitter gourd spiced squash

fact that pre-determined quantity of citric acid was added in all the treatments to maintain acidity around 1.0 per cent. Similar observations have also been reported by Barwal et al (2005) in dietetic bitter gourd ready-to-serve drink. Maximum reducing sugars (22.44%) and total sugars (36.87%) were recorded in T_1 whereas minimum (1.60 and 3.94) in T_5 respectively. It is evident from the data that as the proportion of stevioside was increased from 25 to 100 per cent (Table 3) there was a significant fall of sugar content. This might be attributed to the fact that stevia is carbohydrate free and does not contribute to reducing sugars during analysis (Kumar et al 2007). All the beverages contained good amount of ascorbic acid which ranged from 398.35 to 415.75 mg/100 g whereas total phenols varied between 102.75 to 108.31 mg/100 ml. Data in Table 3 also illustrate the mean organoleptic score for appearance, taste, flavour and overall acceptability of low calorie bitter gourd spiced squash. Non-significant variation in appearance score was observed whereas significantly higher score for taste and flavour (8.00) was recorded in treatment LT_4 (25% sucrose + 75% stevioside). Highest overall acceptability score (8.00) was obtained by LT_4 (25% sucrose +7 5% stevioside) that was at par with treatment LT_3 (50% sucrose +50 % stevioside) whereas minimum was recorded in LT_5 (100% stevioside). The findings are in line with the observations of Tadhani and Subhash (2009) who reported occurrence of bitter after taste of stevioside which becomes more evident with increasing sweetness proportion from 25 to 100 per cent. However Savita et al (2004) has recommended up to 75 per cent substitution of sugar with stevioside in different food products. On the basis of sensory evaluation treatment LT_4 (25% sucrose +75% stevioside) was adjudged the best by the panelists.

The developed products were also assessed for their antimicrobial activity as well as antioxidant potential (Fig 2). Data pertaining to antimicrobial activity against human pathogen (*E coli*) reveal that the developed product had shown higher zone of inhibition (28.00 mm) compared to control (13.50 mm). Similarly highest antioxidant activity (83.33%) was recorded in developed product (LT_4) while control showed only 25.85 per cent free radical scavenging activity (Fig 3). The possible reason for higher antioxidant potential of the developed product could be added ascorbic acid and other constituents like spices which might have contributed to the antioxidant activity of the developed product. The highest calculated energy value (153.5 Kcal/100 g) was obtained by the control treatment (standard beverage) whereas the developed product (75% stevioside sweetened) had 44.5 Kcal/100 g energy value (Fig 4). The low calorie value of stevia sweetened spiced squash might be due to the fact that stevia is zero energy high intensity sweetener (Kumar et al 2007). The developmental effort has successfully

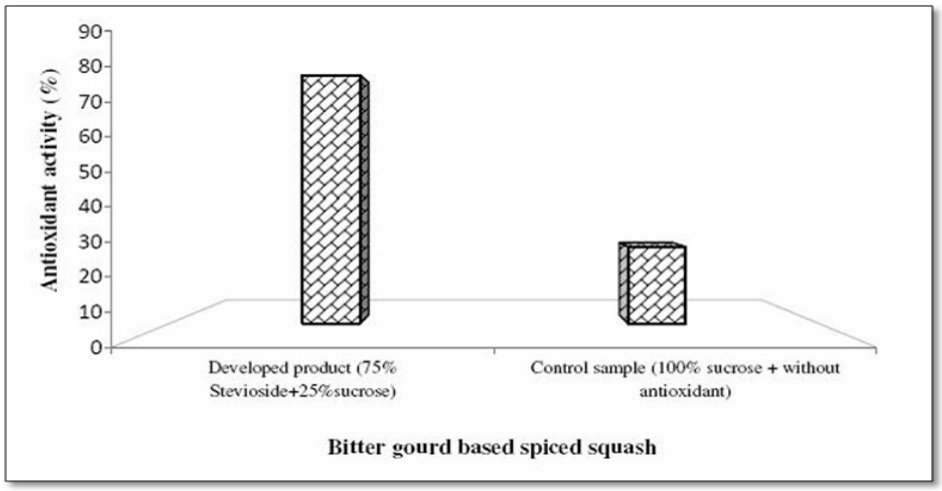

Fig 3. Antioxidant potential of ascorbic acid fortified low calorie bitter gourd spiced squash

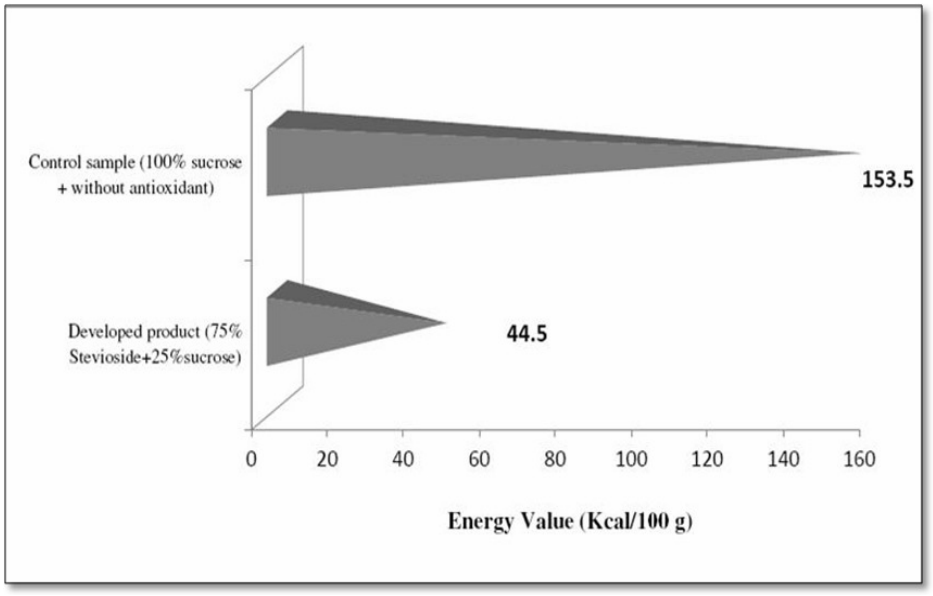

Fig 4. Calculated energy value of ascorbic acid fortified low calorie bitter gourd spiced squash

reduced the calorie value up to 60 per cent per serving when 75 per cent sugar was substituted with the sweetness of stevioside. Sharma et al (2013) had also attained 70 per cent reduction in calorie value per serving at 100 per cent sweetness level of

sorbitol without compromising sensory quality in bitter gourd RTS drink.

CONCLUSION

Current work was focused on ascorbic acid fortification and use of stevioside for the development of antioxidant rich low calorie bitter gourd appetizer. The results showed that the standard appetizer prepared with 27.5 per cent juice, 45°B TSS, spice extract SE_2 and fortification with 0.5 per cent ascorbic acid was rated best on the basis of sensory evaluation. Further the spiced squash prepared by replacing sugar with 75 per cent stevioside sweetness was adjudged the best. The energy value of the product was reduced up to 60 per cent at 75 per cent stevioside sweetness compared to the standard control sample. Hence their availability in the market will definitely benefit the 'at risk group' ie diabetics, obese and health conscious people.

REFERENCES

Amerine MA, Pangborn RM and Roessler EB 1965. Principles of sensory evaluation of food. Academic Press, New York, pp 350-480.

Aneja KR 2003. Experiments in microbiology, plant pathology and biotechnology. 4th edn, New Age International Ltd Publishers, New Delhi, India, 607p.

Barwal VS and Sharma R 2001. Standardization of recipe for the development of plum appetizer. Journal of Food Science and Technology **38:** 248-255.

Barwal VS, Sharma R and Singh TK 2005. Development and evaluation of dietetic bitter gourd ready-to-serve drink. Journal of Food Science and Technology **42:** 202-205.

Brand-Williams W, Cuvelier M and Berset C 1995. Use of free radical method to evaluate antioxidant activity. Lebensmittel Wissenschaft-und-Technologie **28:** 25-30.

Cochran WG and Cox GW 1967. Experimental designs. John Wiley and Sons Inc, New York.

Din A, Bukhari SAH, Salam A and Ishfaq B 2011. Development of functional and dietetic beverage from bitter gourd. International Journal of Food Safety **13:** 355-360.

Horax R, Hettiarachchy N, Islam S 2005. Total phenolic contents and phenolic acid constituents in 4 varieties of bitter melons (*Momordica charantia*) and antioxidant activities of their extracts. Journal of Food Science **70(4):** 275-280.

Joshi G, Singh J, Mishra NP, Khanuja SPS 2006. *Stevia rebaudiana*: an exotic multifaceted medicinal plant of drugs and pharmaceutical industries. Journal of Medicinal and Aromatic Plant Sciences **28(4):** 593-600.

Kalia M and Sood S 1996. Energy. In: Food preservation and processing. Kalyani Publishers, New Delhi, India, pp 66-75.

Kalra CL, Berry SK and Kulkarni SG 1988. Bittergourd – a unique vegetable. Indian Food Packer **42(2):** 35-45.

Kumar S, Jha YK and Singh P 2007. Stevia a natural potential source of sugar replacer. Beverage Food World **34(7):** 70-71.

Lal BB, Joshi VK, Sharma RC and Sharma R 1999. Preparation and evaluation of apple and ginger based squash. Journal of Scientific and Industrial Research **58:** 530-532.

Moczara C, Borgulyab G, Kovacsc E and Rurikc I 2012. Could primary care dietary intervention combined with lifestyle changes be effective in

the cardiovascular prevention? Acta Alimentaria **41(2):** 248-256.

Pandey A and Nigam P 1987. Non-nutritive sweeteners in food systems. Indian Food Industry **6 (4):** 157-165.

Raman A and Lau C 1996. Anti- diabetic properties and phytochemistry of *Memordica charantia* L (Cucurbitaceae). Phytomedicine **2:** 349-362.

Ranganna S 1986. Handbook of analysis and quality control for fruit and vegetable products. 2nd edn, Tata McGraw Hill Publishing Company Ltd, New Delhi, India.

Satkar KP, Kulthe AA and Chalke PR 2013. Preparation of bitter gourd ready-to-serve beverage and effect of storage temperature on its keeping quality. The Bioscan **8(1):** 115-117.

Savita SM, Sheela K, Sunanda S, Shankar AG, Parama R and Srinivas S 2004. Health implications of *Stevia rebaudiana*. Journal of Human Ecology **15(3):** 191-194.

Sharma R, Barwal VS and Joshi VK 2013. Development of low calorie dietetic beverages from fruits and vegetables using non-nutritive sweeteners. Proceedings, National Seminar on Indian Agriculture: Present Situation, Challenges, Remedies and Road Map, 4-5 August 2012, CSK Himachal Pradesh Krishi Vishwavidyalaya, Palampur, HP, India, pp154-157.

Singh S and Gaikwad KK 2012. Studies on the development and storage stability of bitter gourd- lemon functional ready-to-serve beverage. International Journal of Processing and Post Harvest Technology **3(2):** 306-310.

Sumathi M, Samuel SD, Parthiban S 2005. Stevia - a way to sweeten diabetics life. Indian Coffee **69(10):** 12-15.

Tadhani M B and Subhash R 2009. Preliminary studies on *Stevia rebaudiana* leaves: proximal composition, mineral analysis and phytochemical screening. Pakistan Journal of Medical Sciences **6(3):** 321-326

Verdi JR and Hood LL 1993. Advantages of alternative sweeteners blends. Food Technology **47(6):** 94-102.

Received: 23.5.2014 ***Accepted: 27.11.2014***