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RESEARCH PAPER

Standardisation of recipe for the preparation of nectar from sweet orange (*Citrus sinensis* Osbeck) var. sathgudi using sugar substitutes and its storage

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SUMMARY : The investigation is on standardization of recipe for preparation of nectar from sweet orange (*Citrus sinensis* Osbeck) var. sathgudi using sugar substitutes. The experiment was laid out in Factorial Completely Randomised Design with three replications and 6 treatments *viz*., fructose, aspartame, sucralose and their combination with cane sugar (Sucrose) with 24 per cent juice and 0.2 per cent acidity. nectar with sucrose was the control. Sugar substitutes were used in place of sugar based on sugar equivalents. Nectar recipes were analysed for chemical composition and sensory quality attributes at 0, 3 and 6 months intervals in ambient conditions. In sensory evaluation, nectar with fructose, nectar with sucralose, 50 per cent sucrose + 50 per cent fructose and 50 per cent sucrose + 50 per cent sucralose were at par with control (Standard) in respect of overall acceptability scores and rated the better recipes. Nectar had storage stability upto 6 months.

Key Words : Nectar, Sugar substitutes, Sathgudi, Sensory analysis, Storage, Sweet orange

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Sugar substitutes are the food additives used in very small quantities to sweeten foods which provide zero or few calories and offer attractive dietary options for diabetics and people who are trying to limit calorie intake and reduce the risk of tooth decay (Meister and Kava, 2006). Population suffering from diabetes is increasing year by year in India. Inclusion of sugar substitutes in place of sugar for preparation of nectar or any other sweet orange beverages would greatly benefit diabetics and health conscious population. Sweet orange juice is known for health promoting properties (Ladaniya, 2008).Preparation of fruit beverages with sugar substitutes is a new area of research and therefore, an investigation was carried out to standardize sweet orange nectar preparation using sugar substitutes.

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EXPERIMENTAL METHODS

The experiment on standardization of recipe for preparation of nectar from sweet orange (*Citrus sinensis* Osbeck) var. sathgudi using sugar substitutes was carried out in the processing laboratory of the Division of Post Harvest Technology, Indian Institute of Horticultural Research, Bengaluru from November, 2009 to June, 2010. Sweet orange fruits (Var. Sathgudi) of optimum maturity and colour were procured from the sweet orange gardens of Anantapur district, Andhra Pradesh and were washed in potable water, peeled using stainless steel knives, albedo portion was removed, juice sacs were separated from segments and blended in a mixer. The juice obtained was filtered using muslin cloth. The juice was analysed for TSS and acidity and recipes of nectar with sugar substitutes were prepared. The recipe of nectar with 24

per cent juice, 15^0 Brix and 0.3 per cent acidity which was standardized using sucrose in earlier experiment was used (Byanna, 2010). Acidity was adjusted to 0.2 per cent in all the treatments. However, sugar substitutes were used in place of sugar (Based on sugar equivalents) for preparation of nectar. The treatments were nectar with fructose, aspartame, sucralose, 50 per cent sucrose+50 per cent fructose, 50per cent sucrose+50 per cent sucralose, 50 per cent sucrose +50 per cent aspartame and a control (Sugar). The required quantities of juice, sugar substitutes, water and citric acid were calculated. Strained fruit juice and freshly prepared sugar syrup were mixed together in the proportion as per the recipes on weight basis. The mixture was heated on low flame until boiling. The prepared hot nectar was filled into the pre sterilised glass bottles of 200 ml capacity, sealed using crown caps, processed in boiling water for 20 minutes, except in case of aspartame. The pre sterilized bottles filled with hot juice were not pasteurized after adding aspartame pellets due to loss of some sweetening characteristics of aspartame. It was then air cooled, labeled and stored in ambient conditions. Chemical analysis and sensory evaluation were carried out at an interval 0, 3 and 6 months of storage. The sensory evaluation was performed by a panel of 10 judges.

Total soluble solids (TSS) were measured using refractometer (Erma), pH was determined using Elico digital pH meter. Titratable acidity, ascorbic acid, reducing sugars and total sugars were estimated as per the procedure suggested by Ranganna (1979, 1991). Non-reducing sugars were obtained by deducting the value for reducing sugars from the total sugars. The experiment was laid out in Factorial Completely Randomised Design with six treatments and a control replicated thrice. The data were subjected to statistical analysis as suggested by Sundarraj *et al.* (1972).

EXPERIMENTAL FINDINGS AND ANALYSIS

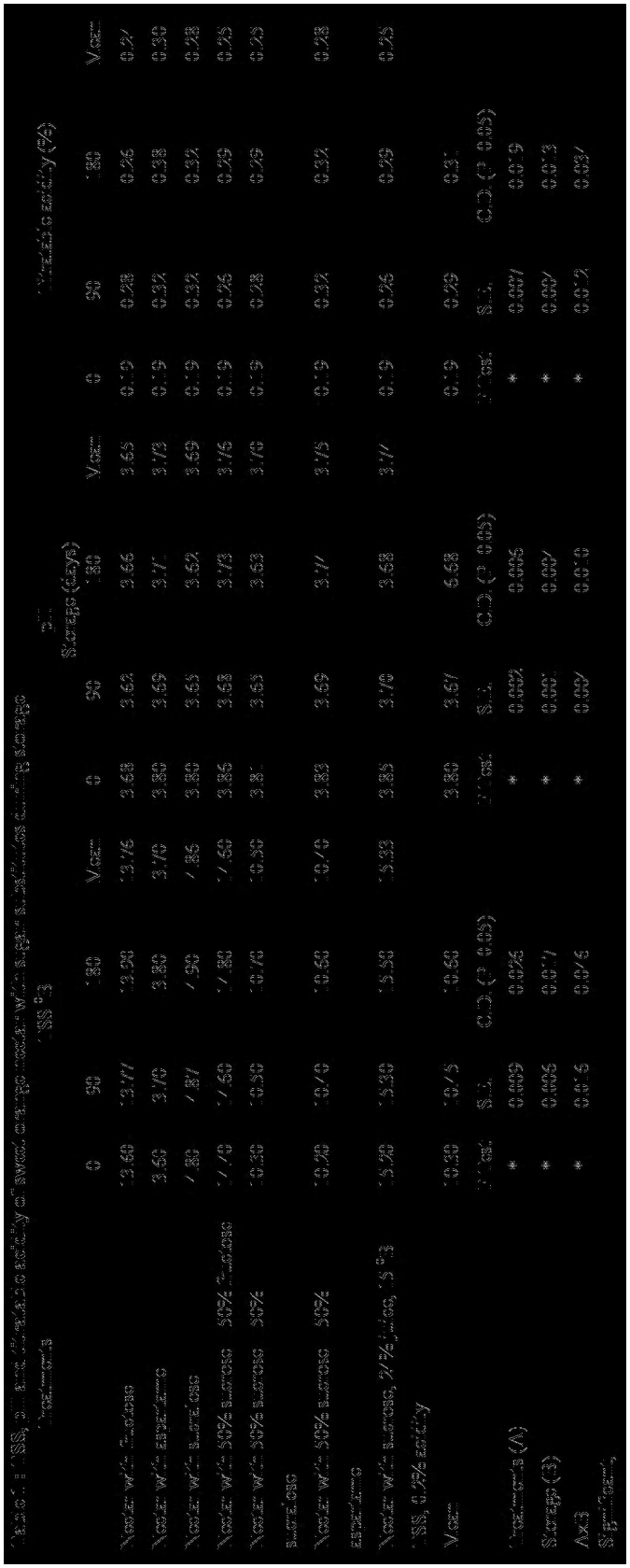
The results of the present study as well as relevant discussions have been presented under following sub heads:

Chemical composition of sweet orange nectar with sugar substitutes and changes during storage:

Total soluble solids:

Sweet orange nectar with sucrose (sugar) showed higher TSS, while nectar with aspartame had least TSS (Table 1). Increase in the proportion of sugar substitutes in place of sugar in nectar decreased TSS content. Sugar substitutes have low calorie or no calories and their addition in sweet orange nectar did not raise TSS, while sucrose (sugar) being non- reducing disaccharide had high TSS. Similar results have been reported by Nishad and Gowda (2006) and Barwal *et al.* (2002).

Storage of nectar increased TSS content. This might be due to solubilization of pulp constituents and increased acidity. Similar findings were reported by Barwal *et al.* (2002).



pH:

Significant differences were found in pH of different recipes of sweet orange nectar (Table 1). Nectar with 50 per cent sucrose + 50 per cent fructose exhibited higher pH while least pH, was in nectar with fructose. pH values of nectar decreased during storage due to simultaneous increase of titratable acidity (Doodnath and Neela Badriel, 2000). Higher pH was found in nectar with 50 per cent sucrose + 50 per cent fructose, nectar with sucrose and nectar with 50 per cent sucrose + 50 per cent aspartame at 0, 90th and 180th day of storage, respectively. This may be attributed to hydrolysis during storage.

Titratable acidity:

Nectar with aspartame had higher titratable acidity, while nectar with fructose had least acidity (Table 1). Aspartame consists of amino acids such as phenyl alanine and aspartic acid linked to methanol. Prolonged storage breakdown aspartame into phenyl alanine, aspartic acid, methanol, and diketopiperazine. These compounds might have reacted with pulp constituents and increased titratable acidity in nectar with aspartame (Kroger *et al.,* 2006).

Acidity increased during storage of nectar due to release of acids from the juice by autolysis which are in agreement with the results of Sogi and Singh (2011).

Ascorbic acid:

Nectar with sucralose had higher ascorbic acid content, while least was found in nectar with sucrose (Table 2). This might be due to loss of ascorbic acid and NEB incase of nectar with sucrose. Decrease in ascorbic acid during storage might be attributed to its degradation into dehydro ascorbic acid, furfural and hydroxyl furfural due to oxidation process and storage temperature. Similar results were reported by Murari and Verma (1989).

Reducing sugars:

Significantly higher reducing sugars were found in nectar with sucrose, while least reducing sugars were found in nectar with aspartame and nectar with sucralose. Sucrose (sugar) being a non-reducing disaccharide on inversion by acids changed to reducing sugars. It might be the reason for higher reducing sugars in nectar with sucrose. Aspartame and sucralose does not contain sugars. Aspartame contains amino acids such as phenyl alanine and aspartic acid, while sucralose is made from sucrose by three chlorine atoms substitution for three OH groups, recorded low reducing sugars.

Reducing sugars increased in all recipes except nectar with fructose. This might be due to high chemical reactivity of fructose and its involvement in non enzymatic browning.

Reducing sugars increased in all treatments during storage. This might be due to hydrolysis or inversion of non-

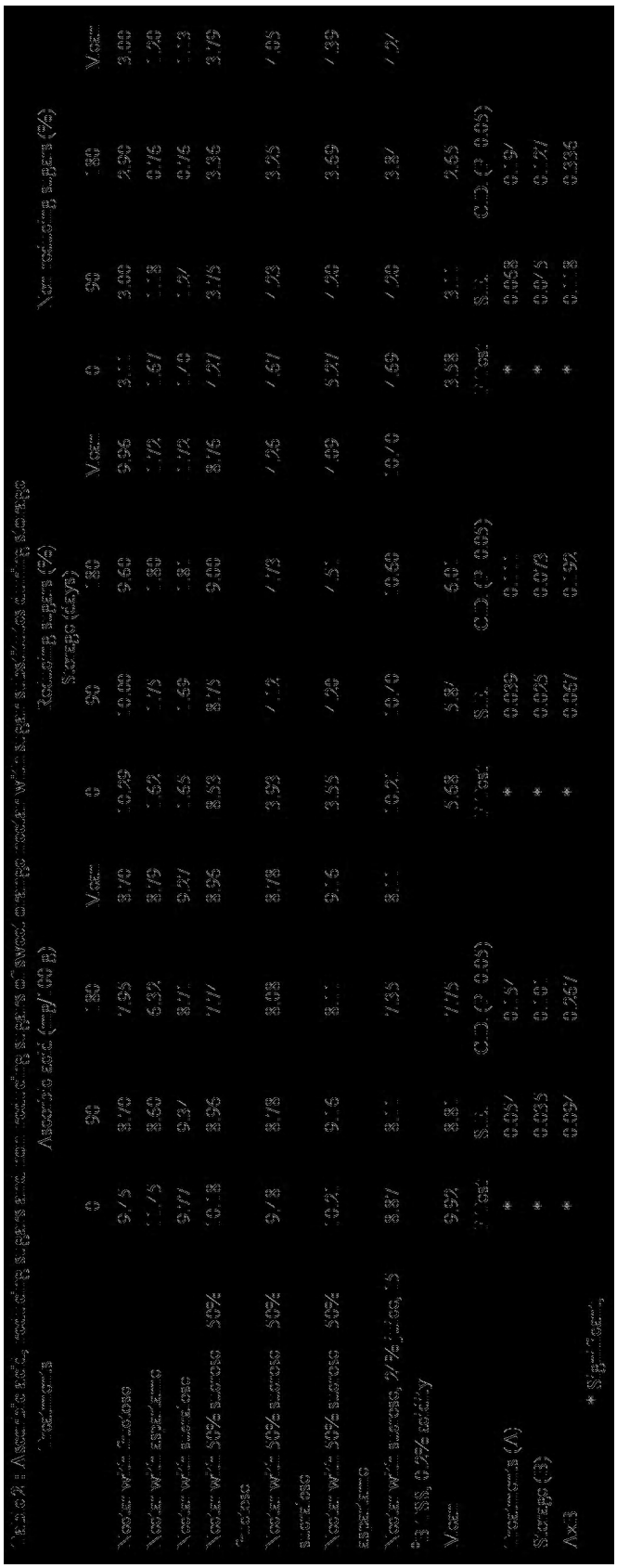


Table 3 : Total sugars of sweet orange nectar with sugar substitutes during storage

Treatments	Total sugars (%) Storage (days)			
	0	90	180	Mean
Nectar with fructose	13.40	13.00	12.50	12.97
Nectar with aspartame	3.29	2.93	2.56	2.93
Nectar with sucralose	3.05	2.93	2.57	2.85
Nectar with 50% sucrose 50% fructose	12.80	12.50	12.36	12.55
Nectar with 50% sucrose 50% sucralose	8.60	8.35	7.98	8.31
Nectar with 50% sucrose 50% aspartame	8.82	8.40	8.20	8.47
Nectar with sucrose, 24% juice, 15 °B TSS, 0.2% acidity	14.90	14.60	14.44	14.65
Mean	9.27	8.96	8.66	
	F Test	S.E.	C.D. (P 0.05)	
Treatments (A)	*	0.067	0.192	
Storage (B)	*	0.044	0.125	
AxB	NS	0.116		

* Significant, NS Non significant

Table 4 : Organoleptic qualities of sweet orange nectar with sugar substitutes during storage

Treatments	Colour				Consistency				Flavour				Overall acceptability			
	Storage period (days)															
	0	90	180	Mean	0	90	180	Mean	0	90	180	Mean	0	90	180	Mean
Nectar with fructose	23.30	19.30	18.70	20.43	23.10	20.60	20.20	21.3	27.60	22.10	21.30	23.67	74.00	62.00	60.20	65.40
Nectar with aspartame	23.60	21.00	18.20	20.93	22.60	19.80	18.30	20.23	26.00	20.80	15.30	20.70	72.20	61.60	51.80	61.87
Nectar with sucralose	23.10	20.60	18.20	20.63	23.00	20.50	19.50	21.00	26.00	23.00	20.90	23.30	72.10	64.10	58.60	64.93
Nectar with 50% sucrose 50% fructose	23.10	20.60	19.10	20.93	23.30	21.00	19.20	21.17	30.00	24.60	25.10	26.57	76.40	66.20	63.40	64.67
Nectar with 50% sucrose 50% sucralose	22.80	20.80	18.70	20.77	23.00	20.60	19.10	20.90	28.60	22.00	20.10	23.57	74.40	63.40	57.90	65.23
Nectar with 50% sucrose 50% aspartame	23.30	20.60	18.20	20.70	22.80	20.00	18.50	20.43	24.80	18.80	20.40	21.33	70.90	59.40	57.10	62.47
Nectar with sucrose, 24% juice, 15 °B TSS, 0.2% acidity	23.30	21.30	17.80	20.80	24.00	21.10	18.60	21.23	30.60	23.80	20.40	24.93	77.90	66.20	55.80	66.63
Mean	23.21	20.60	18.41		23.11	20.51	19.06		27.66	22.16	20.50		73.99	63.27	57.83	
	F Test	S.E.	C.D. (P 0.05)		F Test	S.E.	C.D. (P 0.05)		F Test	S.E.	C.D. (P 0.05)		F Test	S.E.	C.D. (P 0.05)	
Treatments (A)	NS	0.400			NS	0.453			*	0.646	1.789		*	1.187	3.290	
Storage (B)	*	0.262	0.726		*	0.297	0.822		*	0.423	1.171		*	0.777	2.154	
AxB	NS	0.693			NS	0.785			NS	1.118			NS	2.056		

* Significant, NS Non significant

reducing sugars to reducing sugars. The similar results were reported by Barwal *et al.* (2002) and Nishad and Gowda (2006).

Initially nectar with fructose had highest reducing sugars, subsequently at 90th and 180th day of storage nectar with sucrose had highest reducing sugars. Least reducing sugars were found in nectar with aspartame and sucralose (Table 2). This might be due to fructose involvement in chemical reactions with amino acids leading to loss of fructose. Higher reducing sugars in nectar with sucrose at 90th and 180th day might be due to inversion of sucrose to reducing sugars.

Total sugars:

Nectar with sucrose had higher total sugars, while least was found in nectar with sucralose. Sucralose provide zero calorie and used in small amounts in beverages (Meister and Kava, 2006).

The decrease in total sugars during storage was observed (Table 3) due to reaction of sugars and amino acids (Barwal *et al.,* 2002).

Organoleptic qualities of sweet orange nectar with sugar substitutes:

The data pertaining to organoleptic qualities of sweet orange nectar with sugar substitutes are presented in Table 4.

Colour:

Colour scores decreased during storage in all recipes of sweet orange nectar with sugar substitutes. This might be due to oxidative loss of pigments; breakdown of pigments and co-polymerization interaction between phenolics and proteins as well as the formation of certain complexes with pectins during storage (Wilson and Burns, 1983).

Consistency:

Consistency scores were decreased during storage of sweet orange nectar due to change in juice composition during storage and reduction in cloudiness and viscosity.

Flavour:

Flavour score was highest in nectar with sucrose due to interaction with organic acids, changes in the ratios between volatile flavour compounds (Lesschaeve and Etievant, 1991). Decrease of flavour scores during storage was due to loss of volatile flavour compounds.

Over all acceptability :

Highest overall acceptability score was found in nectar with sucrose due to better colour, consistency and flavour scores. Similar results were reported by Barwal *et al.* (2002) in plum seasoned squash.

Decrease in overall acceptability scores during storage was due to decrease in colour, consistency and flavour scores during storage.

Conclusion:

Nectar with fructose, sucralose, 50 per cent sucrose + 50 per cent fructose and 50 per cent sucrose + 50 per cent sucralose were at par with control (Standard) in respect of overall acceptability scores and rated the better recipes.

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