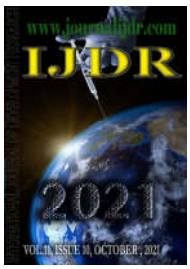
ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 11, Issue, 10, pp. 51068-51072, October, 2021
https://doi.org/10.37118/ijdr.23147.10.2021



RESEARCH ARTICLE OPEN ACCESS

EVALUATION OF ALOE VERA-STEVIA INCORPORATED FRUIT NECTAR

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ARTICLE INFO

Article History:
Received 20th August, 2021
Received in revised form
06th September, 2021
Accepted 11th October, 2021
Published online 30th October, 2021

Key Words:
Aloe vera nectar, Aloe vera fruit nectar, Aloe vera-stevia low calorie nectar, Aloe vera-fruit-stevia-low calorie nectar, low calorie fruit nectar.

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ABSTRACT

This study aims to develop and evaluate the fruit nectar products in which the fruit juice and sugar were substituted with Aloe vera and stevia at various levels (treatment 1- 0%, treatment 2 - 25%, treatment 3 - 50%, treatment 4 - 75% and treatment 5 - 100%). Inulin was used for compensating the sucrose omission defects on TSS, bulkiness (mouth feel) properties of the nectar with numerous health benefits. The sensory evaluation of the treatments and their physico-chemical properties were studied and the well accepted products from sensory evaluation were selected for shelf-life studies. The results revealed that the products with aloe vera and stevia substitution up to 50% were well acceptable. From the physico-chemical properties, TSS, pH and the titratable acidity of all the treatments were made up to 15%, 3.5 and 0.3% respectively. The protein, total sugars, reducing sugars and ash values was observed to be decreasing. The sensory evaluation and the microbial studies conducted during the storage period of 90 days showed an acceptable result. The products with aloe vera substitution up to 50% and stevia up to 50% (i.e., T_1, T_2 and T_3) were found to be the best among the above treatments.

Citation: ***Devanand Haritha and DR. Kavita Waghray.*** "Evaluation of aloe vera-stevia incorporated fruit nectar.", *International Journal of Development Research*, 11, (08), 51068-51072.

INTRODUCTION

The General Codex norm defines a fruit juice as the unfermented but fermentable liquid derived from the edible part of healthy fruits which have reached the appropriate degree of ripening and is fresh or preserved under healthy conditions in accordance with relevant provisions of the Codex Alimentarius Commission. Fruit nectars are prepared from purees, fruit juices obtained from purees, juices or fruit concentrates, mixed with water, sugar and/or honey, syrups and/or other sweeteners. This should contain at least 25 % of fruit juice. Apples (*Malus domestica*) are rich source of phytochemicals. Consumption of apples reduces the risk of cardiovascular disease, asthma, cancers, diabetes. It has very strong antioxidant activity, inhibit the cancer cell proliferation, decreases lipid oxidation and lower cholesterol (Boyer and Liu 2004).Grapes (*Vitis vinifera*) are known to be a good source of various nutrient elements, such as vitamins, minerals, carbohydrates, edible fibres and antioxidants. The most important antioxidants present in the grapes are in the form of polyphenols and flavonoids.

The epidemiological studies have reported that increased intake of natural phenolic antioxidants from grapes reduces coronary heart disease, cancer and neurodegenerative diseases (Ayed*et al.,* 2017).
The Aloe vera is the oldest known medicinal plant and among that the widely used variety of Aloe vera is *Aloe barbadensismillar*. *Aloe vera* is a perennial, succulent plant with stiff fleshy leaves. Aloe verais one of the oldest known medicinal plants. The Aloe vera leaves consists of clear thin gelatinous material. Most of the health benefits associated with Aloe vera have been attributed to the polysaccharides present in the leaf gel. These biological activities include promotion of wound healing, hypoglycemic or antidiabetic effects, antifungal activity, anti-inflammatory, immunomodulatory, anticancer and gastroprotective properties (Hamman 2008). Now a day's Sugar-free foods and beverages are very popular, and the sweeteners that make them possible are among the most conspicuous ingredients in the food supply. These safe sweeteners are of benefit to consumers as it enables food scientists to formulate a variety of good-tasting sweets, foods and beverages. Consumers often select these foods and beverages because they want the taste of sweetness without added calories (Kroger *et al.,* 2006).

Stevia is one of the natural sweeteners which is extracted from leaves of the plant (*Stevia rebaudiana Bertoni*), and produces diterpene glycosides which are low calorie sweeteners. Stevia extracts contain a high level of sweetening compounds, known as steviol glycosides. Stevia contains sweet substances which are 250 to 300 times sweeter than sucrose and it is also considered as safe (GRAS) by the FDA (Abolila*et al.,* 2015). Inulin is present in over 3000 vegetables, it is considered to be extensively distributed in various plants like chicory roots, Jerusalem artichoke, dahlia tubers. It has been a part of our daily food intake for centuries. It is contributing to nutritional properties and exhibits significant technological benefits. Inulin is widely used as a fat replacer, sugar replacer or to impart desirable characteristics. It gives 25 to 35% of energy when compared with digestible carbohydrates. It is an appropriate ingredient for the preparation of low caloric foods to manage blood sugar levels (Shoaib *et al.,* 2016). So, this study aims to develop and evaluate the *Aloe vera* - stevia incorporated fruit nectar by substituting the fruit juice with *Aloe vera* juice from 0% to 100% and sugar with stevia from 0% to 100%.

MATERIALS AND METHODS

Materials: Aloe vera incorporated fruit nectar in combination with natural sugar substitute, stevia was prepared in 2017. The Aloe vera gel was procured from theBhaskara Biotech (Manufacturer of Aloe vera products), Ranga Reddy Dist., Telangana, India. The other ingredients like fruits, sugar, stevia, inulin and citric acid were procured from the local market.

Preparation of nectar: The mixed fruit pulp was prepared by using two types of fruits, apple and grapes. The apples and grapes were cleaned, peeled (only apples), ground to extract juice. The apple and grape juice were blended in 70% and 30% ratio. Now this fruit juice was substituted with Aloe vera juice in 0%, 25%, 50%, 75% and 100% compositions. The total soluble solids and total acidity were determined, according to which the required amount of sugar and acid was calculated (Srivastava and Kumar 2017). This calculated sugar was substituted by stevia which is 300 times sweeter than sucrose/sugar (Shoaib *et al.,* 2016) in 0%, 25%, 50%,75% and 100% compositions. And inulin was added to compensate the decrease in TSS in half the quantity of reduced sugar in each treatment. The sugar syrup was prepared by adding water, sugar, stevia, inulin and acid which was heated just to dissolve. The fruit-Aloe vera juice was mixed with strained sugar syrup, homogenised, crown corked, pasteurised, cooled and stored (Srivastava and Kumar 2017).

Sensory evaluation: Sensory evaluation for colour, taste, flavour, texture and overall acceptability of Aloe vera-stevia incorporated fruit nectar treatment products were carried out using a 9-point hedonic scale method with 10 trained panel members (Amerine *et al.,* 1965).

Physicochemical Analysis: The physicochemical properties like TSS, pH, Titratable acidity, protein and ash content for the prepared Aloe vera-stevia incorporated fruit nectar treatments were analysed by using standard methods (Ranganna 1986). The total sugars and reducing sugars were determined by using (AOAC 2000) method.

Microbiological evaluation: The microbial quality of the prepared nectar products was analysed by conducting total plate count, E. Coli (**Escherichia coli)**, yeast and mold tests according to the standard (IS:5402-2012), (IS:5403:1999) and (IS: 5887 part 1 1976) methods.

Shelf-life analysis: The shelf-life analysis was conducted by studying sensory evaluation and microbial analysis for a storage period of 90 days at regular interval of 45 days.

Statistical method: The data collected from sensory evaluation with 10 trained panel members and the physico-chemical analysis was analysed statistically with ANOVA single factor method. The sensory evaluation and the microbial analysis conducted during storage period were analysed with ANOVA two factorial with replication method.

RESULTS

Sensory evaluation: In this study an attempt was made to develop Aloe vera - stevia incorporated fruit nectar. The organoleptic evaluation data of Aloe vera nectar products are given in table 1. The data indicates significant differences in sensory attribute scores except texture attribute between the different treatments at ($p< 0.01$) level.

Physicochemical Analysis: The data presented in table 2 shows that there was no significant difference in TSS, pH and titratable acidity. The acidity of the nectar samples should be 0.3% and pH 3.5 (Srivastava and Kumar 2017). So, acidity and pH values were made to these standard values by adding citric acid. The TSS of the nectar treatments were prepared with nearly 15%. For this the TSS of the juice blends were identified and then the TSS of the prepared nectar treatments were made up to 15% TSS by adding other solid ingredients of the product. The protein decreased significantly at ($p<0.05$) level. The total sugars, reducing sugars and ash values of different treatments showed a significant difference at ($p<0.01$) level.

Shelf life studies

Sensory evaluation: The results of sensory evaluation for the well acceptable products Treatment 1, Treatment 2 and Treatment 3 during storage period are given in table 3. The storage period decreased the colour, taste, flavour and overall acceptability score significantly ($p<0.01$).

Microbiological evaluation: The selected nectar samples were microbiologically analysed and presented in Table 4. There was no significant growth of E. coli. The TPC, yeast and mold count showed significantly difference at ($p<0.01$) level with increase in Aloe vera juice percentage and during the storage period.

DISCUSSION

Sensory evaluation: The colour, taste and flavour decreased with increase in Aloe vera - stevia percentage. This might be due to light colour, less taste and flavour of Aloe vera juice. Similar results were found in Aloe vera peda products (Srikanth *et al.,* 2017b) and stevia incorporated jamun nectar and rts (ready-to-serve) beverages (Panda *et al.,* 2019). There was no significant difference in texture of all treatments even though sugar percentage decreased. This could be because of maintaining TSS by adding inulin as a bulking agent. The addition of inulin from 0-8% increased the TSS of low-calorie milk drinks (Mittal and Bajwa 2012). The overall acceptability of the products also decreased with increase in Aloe vera - stevia percentage. These results are in acceptance with (Chaudhary *et al.,* 2017) and (Vahedi and Mousazadeh 2016). And the Treatments 1,2 and 3 were selected for the shelf-life studies.

Physico chemical properties: The TSS, acidity and pH of all the nectar samples were found to be 15%, 0.3% and 3.5. The protein content of the treatments decreased as the Aloe vera juice content increased. The similar results were observed in peach jam prepared by incorporation of Aloe vera gel (Ali *et al*., 2021). The total sugars, reducing sugars and ash values of different treatments showed a significant difference at ($p<0.01$) level. The total sugars and reducing sugars showed a decrease in the value as the sucrose percentage decreased. The low-calorie jam developed by replacement of sugar with stevia showed similar results (Sutwal *et al.,* 2019).The ash content decreased with increase in aloe vera percentage. This could be due to low ash content of aloe vera gel (Elbandy *et al.,* 2014). Similar result was observed in a study of Aloe vera based ready to serve soft drinks (Talib *et al.,* 2016).

Shelf life studies

Sensory evaluation: The storage period ofthe well acceptable products decreased the colour, taste, flavour and overall acceptability score significantly ($p<0.01$).

Table 1. Sensory evaluation of Aloe vera-stevia incorporated fruit nectar treatments

Treatments	Sensory Attributes				
	Color	Taste	Flavor	Texture	Over all acceptability
Treatment 1 (control)	8.6±0.51	8.4±0.51	7.9±0.56	8.3±0.48	8.2±0.42
Treatment 2	8.1±0.56	7.8±0.63	7.6±0.51	8.4±0.51	7.8±0.42
Treatment 3	7.5±0.52	7.3±0.48	7.2±0.42	8.4±0.51	6.6±0.51
Treatment 4	6.4±0.51	5.8±0.42	5.5±0.52	8.3±0.67	4.8±0.63
Treatment 5	5.6±0.51	5.4±0.51	4.8±0.63	8.2±0.42	3.2±0.63
p-value	1.29E-16	9.78E-18	4.15E-18	0.908162	1.05E-25

Table 2 The physico-chemical properties of the Aloe vera-stevia incorporated fruit nectar treatments

Treatments	Physico-chemical properties						
	TSS (%)	pH	Titratable acidity (%)	Protein (g/100g)	Total sugars (g/100g)	Reducing sugars (g/100g)	Ash (g/100g)
Treatment 1 (control)	15±0.0	3.51±0.01	0.31±0.005	0.99±0.51	14.8±0.05	10.46±0.005	0.290±0.0005
Treatment 2	14.3±0.57	3.49±0.01	0.31±0.01	0.94±0.01	10.57±0.01	9.17±0.01	0.283±0.0005
Treatment 3	14.6±0.57	3.5±0.01	0.32±0.0	0.71±0.005	9.17±0.01	8.06±0.005	0.275±0.001
Treatment 4	14.6±0.57	3.5±0.01	0.31±0.005	0.53±0.005	8.65±0.005	6.87±0.005	0.267±0.0005
Treatment 5	14.3±0.57	3.49±0.005	0.303±0.005	0.36±0.015	4.2±0.005	3.22±0.005	0.265±0.0005
P-value	0.512105	0.912113	0.09689	0.034504	6.78E-22	2.06E-26	2.83E-12

Table 3. Sensory evaluation of the Aloe vera-stevia incorporated fruit nectar treatments during storage period

Treatments	Sensory Attributes														
	Color			Taste			Flavor			Texture			Over all acceptability		
	0^{th} Day	45^{th} Day	90^{th} Day	0^{th} Day	45^{th} Day	90^{th} Day	0^{th} Day	45^{th} Day	90^{th} Day	0^{th} Day	45^{th} Day	90^{th} Day	0^{th} Day	45^{th} Day	90^{th} Day
Treatment 1 (control)	8.6±0.51	7.9±0.56	7.0±0.47	8.4±0.516	7.7±0.48	6.8±0.42	7.9±0.56	7.2±0.63	5.5±0.52	8.3±0.48	6.6±0.69	5.6±0.51	8.2±0.42	6.7±0.48	6.0±0.66
Treatment 2	8.1±0.56	7.3±0.67	6.3±0.48	7.8±0.63	7.4±0.51	6.5±0.52	7.6±0.51	6.8±0.42	5.3±0.48	8.4±0.51	6.3±0.48	4.9±0.31	7.8±0.42	6.4±0.51	5.4±0.69
Treatment 3	7.5±0.52	6.9±0.56	5.6±0.51	7.3±0.48	6.5±0.52	5.6±0.51	7.2±0.42	5.6±0.51	4.4±0.51	8.4±0.51	6.0±0.66	4.8±0.63	6.6±0.51	6.3±0.48	4.7±0.48
	P-value			P-value			P-value			P-value			P-value		
Treatments	1.73E-11			9.86E-10			7.06E-11			0.000859			7.3E-05		
Days of storage	7.92E-20			4.59E-09			2.73E-15			4.92E-11			4.88E-10		
Interaction	0.788234			1			0.317734			0.541364			0.043829		

Table 4: Microbial analysis of the Aloe vera-stevia incorporated fruit nectar treatments during storage period

Treatments	Microbial analysis								
	TPC (cfu/g) (Mean±S.D)			E.Coli count (cfu/g) (Mean±S.D)			Yeast &Mould count (cfu/g) (Mean±S.D)		
	0^{th} Day	45^{th} Day	90^{th} Day	0^{th} Day	45^{th} Day	90^{th} Day	0^{th} Day	45^{th} Day	90^{th} Day
Treatment 1 (control)	0±0.0	92±3	798±16.07	0±0.0	2.6±2.51	1.6±2.88	0±0.0	21.3±8.32	61±19.15
Treatment 2	0±0.0	87.6±2.51	751±10.53	0±0.0	2.6±2.51	3±3	0±0.0	16±4.58	24.6±3.51
Treatment 3	0±0.0	81.6±3.51	609.3±11.01	0±0.0	0.6±1.15	0.6±0.57	0±0.0	10.6±3.05	19.3±3.21
	P-value			P-value			P-value		
Treatments	9.59E-13			0.272196			0.00021		
Day of storage	1.41E-31			0.07106			3.95E-08		
Interaction	8.51E-14			0.769242			0.000718		

This could be due to increase in acidity of the nectar treatments. The sensory attributes decreased during storage period (Kausar*et al.,* 2016). The texture attribute value of all the acceptable samples also decreased significantly ($p<0.01$). This could be due to hydrolysis of sucrose and inulin to reducing sugars during storage period. There was a marked increase in reducing sugars for all the fortified banana juice samples stored at various temperatures as the storage period increased (Yousaf *et al.,* 2009). The sensory evaluation of the three nectar samples showed a decreasing value with acceptable range till 60^{th} day of storage period.

Microbiological evaluation: There was no significant growth of E. coli, but the TPC, yeast and mold count increased during the storage period. Similarly there was an increase in the microbial growth in aloe vera incorporated peda products during storage period (Srikanth *et al.,* 2017a).The TPC, yeast and mold count decreased significantly at ($p<0.01$) level with increase in Aloe vera juice percentage. This explains the anti-microbial effect of Aloe vera. A study explained that the total bacterial counts decreased as a result of Aloe vera gel addition with 20% to 25% (Elbandy*et al.,* 2014). The total plate count, yeast and mould count and E. Coli of all the samples showed an acceptable range of microbial growth till 60^{th} day in reference to the (FSSAI 2018) standards.

CONCLUSION

The substitution of apple-grape juice with Aloe verajuice and sugar with stevia was successfully formulated. The sensory evaluation results indicate that apple-grape juice and sugar can be substituted up to 50% with Aloe vera juice and stevia with best overall acceptability. And inulin can be used for compensating the sucrose omission defects on rheological properties of the nectar with numerous health benefits. The physico-chemical properties study revealed that the pH, TSS, titratable acidity was maintained according to the standards and protein was found to be same for all treatments. Total sugars and reducing sugars decreased from Treatment 1 to Treatment 5. Ash was increased with increase in Aloe vera - stevia substitution. The storage studies (sensory evaluation and microbial studies) were conducted on 0^{th} day, 45^{th} day and 90^{th} day. The results revealed that the treatments can be stored for a period of 90 days with acceptable sensory attribute values and microbial acceptable values (according to the FSSAI microbial standards).

Acknowledgement

It gives me immense pleasure in extending my sincere gratitude to V. Bhaskar Rao, CEO, Bhaskara Biotech (Manufacturer of Aloe vera Products), Viveknagar Colony, Jillelaguda, Saroornagar (M), Ranga Reddy Dist.-500097, bhaskarabiotech7@gmail.com for providing the aloe vera juice/pulp required for the project for preparation of the product.

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