Quality attributes, phytochemical profile and storage stability studies of functional ready to serve (RTS) drink made from blend of *Aloe vera*, sweet lime, amla and ginger

Lokesh K. Mishra¹ · Danme Sangma¹

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Abstract *Aloe vera* based RTS formulation was prepared in this study which provides the health benefits of this wonder plant and was also appealing in terms of sensory qualities. In the present study four formulations of *A. vera* RTS drink with ginger, sweet lime and amla (V1, V2, V3 and V4 were developed). The developed products were subjected to physico-chemical, organoleptic and microbial analysis. The formulation V3 was found to be the most preferred variant with respect to the sensory quality. Further the blends were found to be a good source of vitamin C and other nutritional parameters. The storage stability studies carried out on the formulations showed that the physico-chemical and the sensory qualities of the RTS blends were acceptable after 60 days of storage. Microbial analysis of the RTS blends during the storage period revealed that it was free from any microbial spoilage.

Keywords *Aloe vera* · Ginger · Sweet lime · Amla

Introduction

The increasing demand for soft drinks offers a great scope for development of natural nutrient rich beverages. These drinks help the consumers in having an option which has negligible synthetic chemicals and also has immense health benefits. The growing consumer awareness particularly with regard to health benefits of the products consumed has

led to an exponential growth in the demand for food and also beverages made from natural sources that contain ingredients preferably having nutraceutical properties. New product introductions in the health drink and fruit juice categories were found to reach over 700 new offerings in year 2003, up 40% over 2002 (Anon 2003). Functional beverage sector has been reported to be the fastest growing segment (Roberts 2009). A functional beverage prepared by blending of fruits, vegetables and products from medicinal plants is an emerging sector in food industry. Owing to its nutraceutical and functional properties *Aloe vera* is being explored as a potential ingredient in a wide array of health foods and drinks (Ahlawat and Khatkar 2011; Ramachandran and Nagarajan 2014). New RTS blends having *A. vera* blended with other fruits have been reported earlier by researchers (Ramachandran and Nagarajan 2014; Yadav et al. 2013).

The functional properties and therapeutic benefits of *A. vera* are known worldwide. *A. vera* has been reported to be a source of active substances including vitamins, minerals, enzymes, sugars, anthraquinones of phenolic compounds, lignin, saponins, sterols, amino acids and salicylic acid. Polysaccharides are considered to be the active ingredients for aloe's anti-inflammation and immune modulation effects (Pugh et al. 2001). The aloe gel is transparent slippery mucilage containing bioactive polysaccharides, mainly partially acetylated glucomannans in addition to desired vital nutrients (Rodriguez et al. 2010). *A. vera* gel derived from the leaf pulp of the plant has become a big industry worldwide due to its application in the food industry. It is utilized in functional foods especially for the preparation of health drinks. It is also used in other food products including milk, ice cream, confectionery, etc (Ahlawat and Khatkar 2011). Formulations of *A. vera* have also found their use for health, medical and cosmetic

✉ Lokesh K. Mishra
lkmishra2005@gmail.com

¹ Department of Basic Science and Humanities, College of Home Science, Central Agricultural University, Tura, Meghalaya, India

purposes (Enward and Benward 2000). Value addition of *A. vera* based RTS drinks with other medicinal plants like ginger and amla may be an excellent way to deliver these therapeutic benefits of *A. vera* to the consumers.

Ginger (*Zingiber officinale* Rosc.) is a valued spice known for its taste, aroma, flavour and medicinal value. Apart from cooking it is also used purposes like preparation of ayurvedic candy, digestive juices and relevant antiemetic to prevent vomiting, nausea. Ginger has also been recognized for its properties to treat rheumatoid arthritis, ulcer, preventing heart attack and stroke. It has volatile oils zingiberol, zingiberene, phellandrene and linalool that account for the aroma of the tubers (Mukherjee et al. 2014). The use of ginger as antiviral, anti-cancer and anti-ulcerogenic drug has been reported earlier (Denyer et al. 1994).

Amla or Aonla (*Emblica officinalis*) is a sub-tropical deciduous tree indigenous to Indian sub-continent. Amla (Indian gooseberry) and its processed products are rich source of vitamin C, phenols, dietary fibre and antioxidants (Goraya and Bajwa 2015). It is highly nutritive fruit with immense medicinal properties. Amla contains 500–1500 mg of ascorbic acid per 100 g pulp (Chauhan et al. 2005) and is rich in phenols and tannins such as elegiac acid, gallic acid in the fruit prevent the oxidation of vitamin c. The medicinal properties of amla against several ailments like tuberculosis, asthma, bronchitis, scurvy, diabetes, anemia, weakness of memory, cancer and influenza are well known. The fruit juice is slightly acidic and astringent that makes it unpalatable if consumed fresh (Goyal et al. 2008). Processed amla has been successfully incorporated in nutritionally poor products such as ice cream to enhance the functional properties and nutritional quality of these frozen desserts (Goraya and Bajwa 2015).

The sweet lime fruit is processed commercially into various forms like juice, frozen concentrates, squash and RTS drinks which provide energy, moderate quantity of vitamin C, potassium, bioflavonoid and folic acid. The fruit and its juice is refreshing, thirst quenching and energizing that improves health and caters to many nutritional requirements (Syed et al. 2011).

Increasing consumer demand, need for sustained growth of food processing industry and reducing the unpalatable tastes of otherwise nutritionally superior ingredients are important factors which necessitate the development of novel RTS blends. The blending of two or more juices helps in utilization of astringent and acidic fruits like amla. The use of refreshing and tasteful ingredient like sweet lime may help in development of palatable RTS blend

having combined medicinal benefits of *A. vera*, amla, ginger and sweet lime.

Keeping above facts in view the present investigation was undertaken to develop an *A. vera* based RTS blended with juice of amla, ginger and sweet lime.

Materials and methods

The present experiment was conducted at the Department of Basic Science and the Food Processing Unit of the College of Home Science Tura, Meghalaya. Undamaged, mould/rot free and mature *A. vera* leaves were procured from local farmers. *A. vera* pulp was taken out according to the traditional hand filleting method (Yadav et al. 2013). In brief, the lower 1 inch of the leaf base, the tapering point (2–4 inch) of the leaf top and the short, sharp spines located along the leaf margins were removed with a sharp knife, then the knife was introduced into the mucilage layer below the green rind, avoiding the vascular bundles, and the top rind was removed. The bottom rind was similarly removed and the rind parts, to which a significant amount of mucilage remained attached was discarded. The filleting process was completed within 36 h of harvesting the leaves. The pulp was heated to 60–65 °C for 10 min and was mashed with the hand beater. The mashed pulp was strained with muslin cloth to retrieve the juice. This juice was stored under refrigerated conditions for future use.

Other ingredients like ginger, sweet lime, amla, sugar, citric acid and preservative (KMS) was purchased from local market. The juice of the ingredients was extracted with the help of a laboratory blender and the juice was obtained by filtering through muslin cloth and stored separately under refrigerated conditions for future use.

Preparation of the RTS

The *A. vera* based RTS blended with ginger, amla and sweet lime juice was prepared as per the flow chart given in Fig. 1. The RTS was prepared in four different variations coded as V1, V2, V3 and V4. The calculated amount of sugar syrup was added so as to maintain a constant 13°brix. Citric acid @ 0.2% per kg of pulp was added to avoid browning reactions and KMS @ 100 ppm was added as a preservative. The prepared RTS was packed in PET bottles, properly pasteurized and cooled in a refrigerator. The RTS packed in the sealed PET bottles was stored at ambient temperature for 60 days for further analysis.

Fig. 1 Flow chart describing the preparation of *Aloe vera* based RTS formulations

Physio-chemical analysis

The pH values were determined with the help of a Sartorius Professional pH meter (digital pH meter), TSS

measurement was done with the help of a hand refractometer PR-101 (Made in Japan) and values were expressed as °Brix. Acidity of various samples was determined by titrating against 0.1 N NaOH according to AOAC (1995)

Table 1 Physico-chemical analysis of the ingredients used in *Aloe vera* based RTS formulations

S. no.	Physico-chemical properties	<i>Aloe vera</i> juice	Ginger juice	Sweet Lime juice	Amla juice
1.	°Brix	0.09	2.8	14.5	2.9
2.	Acidity (%)	0.06	0.8	1.7	2.4
3.	pH	4.6	4.2	2.76	2.9
4.	Total sugar (%)	1.90	Not detected	10.4	3.23
5.	Vitamin content (mg/100 g)	1.68	3.4	23.16	885.6

method. Reducing and total sugar were determined by the method recommended by (Ranganna 2001).

Phytochemical analysis

Ascorbic acid content was determined by the titration method using 2, 6-dichlorophenol endophenol dye as recommended by (Ranganna 2001).

Microbiological studies

The prepared beverage formulations were studied for microbial load. The total microbial load was calculated by standard plate count method. The standard plate count was done according to the method described in “Recommended method for the microbiological examination of food” (APHA 1967).

Organoleptic evaluation

The fresh and stored beverage samples prepared were served chilled for organoleptic evaluation and it was carried out by semi-trained panel of twenty judges on a 9.0 point Hedonic scale (Amerine et al. 1965).

Statistical analysis

Data obtained for the various parameters were expressed as mean values $\pm$ standard deviations of three replications. Statistical analyses were performed using GraphPad 6.07 software. Data was analyzed using one way ANOVA to check the impact of storage period on the physico-chemical and organoleptic attributes of the formulations developed. Statistical difference between the means was determined using Tukey's test with the confidence limits set at $P < 0.01$ (99%).

Results and discussion

Analysis of raw ingredients

The raw ingredients used for the preparation of the *A. vera* based RTS formulations were analysed for important

physico-chemical properties. The results are tabulated in Table 1. The results suggest that amla juice had the highest vitamin c content (885.6 mg/100 g). The total soluble solids expressed as °Brix was highest in the sweet lime juice (14.5). The pH was recorded highest in the *A. vera* juice (4.6) while it was lowest in sweet lime juice (2.76). Total sugar content was highest in sweet lime juice (10.4) whereas other ingredients were low in the total sugar content. Highest acidity was recorded in amla juice (2.4). Low °brix value and total sugar in the *A. vera* juice are obvious as it has a bitter taste which is the main drawback in utilizing it in the beverage industry. The selection of sweet lime with high °brix and total sugar in this study was done to mitigate the off taste and bitterness of the *A. vera*. Use of amla also contributed to taste whereas using ginger contributed to appealing flavour. Similar efforts to alleviate the bitter taste of the *A. vera* juice has been attempted by other studies also (Yadav et al. 2013; Ramachandran and Nagarajan 2014).

Physico-chemical attributes of the *Aloe vera* based RTS formulations

The physico-chemical attributes of the four variations of the *A. vera* based RTS were studied for 60 days storage period at an interval of 15 days. The ratio of the *A. vera*:ginger:sweetlime:amla in the four variations were (40:5:40:15), (50:5:30:15), (60:5:20:15) and (70:5:10:15) for V1, V2, V3 and V4 respectively. The results of the physico-chemical analysis are presented in Table 2.

The data obtained shows that the pH of the *A. vera* formulations decreased during the storage period from 0 to 60 days after storage. The minimum decrease in pH was observed in the V2 formulation (4.56–4.25) and maximum decrease in pH was observed in V3 formulation (4.80–4.40) during the storage period. The pH of the formulations was also impacted by varying the ingredients to prepare the four formulations of the *A. vera* RTS. There was an increase in the pH for the variations from V1 to V3 and the same trend was observed during the storage period. The decrease in pH during the storage period may be correlated with the increasing acidity as observed in this study. Similar findings have been reported by (Tandon et al. 1983; Sandhu et al. 2001). The decrease in pH has

Table 2 Effect of storage period on physico-chemical parameters of *Aloe vera* based RTS formulations

Duration of storage (days)	Formulations			
	V1	V2	V3	V4
pH				
0 DAS	4.48 ^b ± 0.02	4.56 ^c ± 0.02	4.80 ^e ± 0.01	4.75 ^g ± 0.01
15 DAS	4.40 ^{ab} ± 0.05	4.60 ^{cd} ± 0.02	4.75 ^{ef} ± 0.03	4.62 ^{gh} ± 0.04
30 DAS	4.32 ^a ± 0.02	4.35 ^d ± 0.02	4.60 ^f ± 0.03	4.51 ^h ± 0.02
45 DAS	4.21 ^a ± 0.04	4.30 ^d ± 0.02	4.45 ^f ± 0.03	4.44 ^h ± 0.05
60 DAS	4.15 ^a ± 0.03	4.25 ^d ± 0.04	4.40 ^f ± 0.04	4.42 ^h ± 0.04
Titratable acidity (%)				
0 DAS	0.24 ^a ± 0.02	0.26 ^d ± 0.02	0.27 ^c ± 0.02	0.29 ^b ± 0.01
15 DAS	0.26 ^{ab} ± 0.01	0.29 ^{de} ± 0.01	0.28 ^{cd} ± 0.03	0.31 ^{bc} ± 0.02
30 DAS	0.29 ^b ± 0.01	0.31 ^e ± 0.02	0.33 ^d ± 0.02	0.34 ^c ± 0.02
45 DAS	0.32 ^b ± 0.01	0.33 ^e ± 0.02	0.35 ^d ± 0.03	0.36 ^c ± 0.03
60 DAS	0.35 ^c ± 0.02	0.36 ^f ± 0.02	0.38 ^e ± 0.03	0.39 ^d ± 0.01
Total soluble solids (°Brix)				
0 DAS	13.00 ^a ± 0.00	13.00 ^c ± 0.00	13.00 ^e ± 0.00	13.00 ^g ± 0.00
15 DAS	13.50 ^a ± 0.10	13.75 ^c ± 0.05	13.70 ^c ± 0.05	13.10 ^g ± 0.05
30 DAS	13.70 ^{ab} ± 0.05	14.10 ^{cd} ± 0.05	14.30 ^{ef} ± 0.05	12.90 ^{gh} ± 0.05
45 DAS	14.01 ^a ± 0.07	14.50 ^c ± 0.05	14.80 ^e ± 0.05	13.20 ^g ± 0.05
60 DAS	14.60 ^a ± 0.05	14.80 ^c ± 0.05	14.90 ^e ± 0.05	13.50 ^g ± 0.05
Total soluble sugar (%)				
0 DAS	14.50 ^a ± 0.04	14.70 ^c ± 0.07	16.58 ^e ± 0.08	16.75 ^g ± 0.04
15 DAS	14.35 ^{ab} ± 0.03	14.56 ^{cd} ± 0.02	16.25 ^{ef} ± 0.03	16.34 ^{gh} ± 0.02
30 DAS	13.93 ^{ab} ± 0.04	14.31 ^{cd} ± 0.15	15.86 ^{ef} ± 0.04	15.98 ^{gh} ± 0.02
45 DAS	13.72 ^b ± 0.02	13.85 ^d ± 0.05	15.56 ^f ± 0.03	15.67 ^g ± 0.02
60 DAS	13.56 ^a ± 0.01	13.70 ^c ± 0.05	15.20 ^e ± 0.02	15.29 ^g ± 0.04
Reducing sugar content (%)				
0 DAS	8.45 ^b ± 0.01	8.50 ^c ± 0.06	9.23 ^e ± 0.03	9.32 ^g ± 0.01
15 DAS	8.59 ^{ab} ± 0.02	8.64 ^{cd} ± 0.04	9.38 ^{ef} ± 0.03	9.40 ^{gh} ± 0.04
30 DAS	8.70 ^{ab} ± 0.01	8.85 ^{cd} ± 0.04	9.65 ^{ef} ± 0.03	9.76 ^{gh} ± 0.01
45 DAS	8.86 ^a ± 0.02	8.90 ^d ± 0.04	9.78 ^f ± 0.01	9.87 ^h ± 0.03
60 DAS	8.98 ^a ± 0.01	9.12 ^d ± 0.03	9.89 ^f ± 0.02	10.10 ^h ± 0.04

Each value is the mean of three independent samples. Mean values ± SD

Means followed by same letters within each column were not significantly different. ($P < 0.01$ —Tukey test)

The ratio of the *Aloe vera*:ginger:sweet lime:amla in the four variations were (40:5:40:15), (50:5:30:15), (60:5:20:15) and (70:5:10:15) for V1, V2, V3 and V4 respectively

also been reported by (Hamran and Amutha 2007) in banana and sapota RTS and (Nidhi et al. 2008) in bael-guava RTS. The gradual decrease in the pH may be considered as a positive feature as it has antimicrobial properties and the low pH checks the growth of the pathogenic microorganisms.

The data pertaining to titratable acidity (Table 2) shows that there was significant increase in titratable acidity of all the formulations of the *A. vera* based RTS with storage time. The increase in the titratable acidity was almost similar in all the formulations. The formulations V1 and V3 exhibited an increase of 0.11% and the formulations V2

and V4 had an increase of 0.10% in titratable acidity. A strong correlation between the increase in acidity and decrease in vitamin c content has been reported by (Simsek 2011). Similar trends have been reported by (Nidhi et al. 2008; Yadav et al. 2013; Ramachandran and Nagarajan 2014). The degradation of polyphenols in ginger and amla and rapid conversion of proteins to amino acids in *A. vera* RTS are also the reasons for increase in the titratable acidity of the *A. vera* RTS blends. The findings are corroborated by results reported by Yadav et al. (2013).

The total soluble solids (TSS) in RTS formulations are expressed as °Brix. It is an indicator of sugar content in the

Fig. 2 Effect of storage period on organoleptic attribute scores *Aloe vera* based RTS formulations

RTS blends and it primarily results due to the sucrose, glucose and fructose components. The data pertaining to TSS is tabulated in Table 2. In this study the TSS for all the variations was maintained at 13°Brix initially. There was an increase in the TSS from 0 to 60 days after storage for all the formulations. Minimum increase in the TSS was reported in V4 (13.0–13.5), while the maximum increase was observed in V3 (13.0–14.9). The increase in the reducing sugar due to increase in hydrolysis of total sugar by acid hydrolysis of starch in *A. vera* into simple sugars and formation of invert sugar from sucrose may have led to the increase in TSS values of the RTS formulations during the storage period. Similar trends have been reported in RTS developed from guava by (Kalra et al. 1991), bitter gourd based RTS by (Barwal et al. 2005) and *A. vera*—papaya based RTS by (Ramachandran and Nagarajan 2014), lime blended amla squash by (Reddy and Chikka-subbanna 2008) and *A. vera* based beverage supplemented with mint and ginger by (Yadav et al. 2013). Sadler and Murphy (2010) have suggested that ratio of the TSS and titratable acidity (sweetness index) contributes to the flavour and taste of the fruits and juices.

The data presented in Table 2 shows that there is a decrease in the total sugar content from 0 to 60 DAS in all the formulations of the *A. vera* RTS blends. The minimum decrease was observed in the variation V1 (14.50–13.56%) and the maximum decrease in the total sugar content was seen in V4 which exhibited a decline of 1.46% (16.75–15.29) from 0 to 60 DAS. The decrease in the total sugar content was statistically significant during the storage period. The decline in total sugar content may be attributed to hydrolysis of the complex sugars into simple sugars due to higher acidity. These results are in conformity with the

findings of (Yadav et al. 2013). Studies reported by Verma and Gehlot (2007) in bael (*Aegle marmelos*) based RTS and (Nidhi et al. 2008) in bael-guava RTS are contrary to our results.

Reducing sugar content (in %) (Table 2) reveals an increase in the reducing sugar content during storage period from 0 to 60 days in all the formulations. The reducing sugars are very much instrumental in determining the taste of any fruit or juice sample. The conversion of the complex sugars including the disaccharides (non-reducing sugars) which are important constituents of the total sugar into reducing sugar under acidic conditions is an important reason for the increasing trend seen in this investigation. The trend was evident in all the formulations. These results are in accordance to the findings of (Narayanan et al. 2002; Nidhi et al. 2008; Yadav et al. 2010).

Phytochemical attribute of the *Aloe vera* based RTS formulations

Phytochemical are chemicals produced by plants which may play a role of antioxidants when consumed. The phytochemical analysed in the present research study was Vitamin C content. The results of the impact of storage period and variations on the vitamin c content of the *A. vera* RTS formulations are presented in Table 3. Data indicates significant decreasing trend in the vitamin c content during the storage period from 0 to 60 days in the formulations.

The decrease in the vitamin c content can be attributed to the oxidation sensitive nature of the vitamin and its solubility in water. The maximum decrease in the vitamin c was observed in V1 (11.30–10.42 mg/100 g) and the

Table 3 Effect of storage period on vitamin C content of *Aloe vera* based RTS formulations

Duration of storage (days)	Vitamin C content in formulations (mg/100 g)			
	V1	V2	V3	V4
0 DAS	11.30 ^a ± 0.02	11.45 ^c ± 0.02	11.65 ^e ± 0.02	11.60 ^g ± 0.02
15 DAS	11.15 ^{ab} ± 0.03	11.21 ^{cd} ± 0.02	11.40 ^{ef} ± 0.02	11.42 ^{gh} ± 0.02
30 DAS	10.83 ^b ± 0.02	11.05 ^d ± 0.02	11.32 ^f ± 0.02	11.30 ^h ± 0.02
45 DAS	10.65 ^b ± 0.03	10.86 ^d ± 0.02	11.16 ^f ± 0.02	11.08 ^h ± 0.03
60 DAS	10.42 ^b ± 0.02	10.70 ^d ± 0.03	11.02 ^f ± 0.01	10.95 ^h ± 0.03

Each value is the mean of three independent samples. Mean values ± SD

Means followed by same letters within each column were not significantly different. ($P < 0.01$ —Tukey test)

The ratio of the *Aloe vera*:ginger:sweet lime:amla in the four variations were (40:5:40:15), (50:5:30:15), (60:5:20:15) and (70:5:10:15) for V1, V2, V3 and V4 respectively

minimum decrease was observed in V3 formulation (11.65–11.02 mg/100 g). Decreasing trend in the vitamin c content has also been reported by (Nidhi et al. 2008) in bael-guava RTS during storage. Similarly Ramachandran and Nagarajan (2014) reported that the decrease in vitamin c content in spiced papaya beverage was up to 74 and 79% during 90DAS and 150DAS respectively. The decrease in the present investigation ranged from 5.4 to 7.8% only. This decline in this study may be due to high antioxidative properties of *A. vera* (Hu et al. 2003) which may have had a protective impact and prevented the oxidation of vitamin c in the RTS formulations prepared. Similar results have been reported by (Yadav et al. 2013).

Sensory attributes of the *Aloe vera* based RTS formulations

The *A. vera* based formulations were evaluated for the sensory attributes during the storage period. The results (Table 4) indicates that variation V3 scored significantly higher scores with respect to all the sensory attributes like appearance, mouth feel, taste, flavour and overall acceptability. In formulating the RTS blend in the present study *A. vera* and sweet lime concentrations were changed to prepare the four formulations. One of the limitations of the *A. vera* juice/beverages is its bitter and off taste. The increase in the sweet lime juice concentration which is known for its delicious taste up to 20% had a positive impact on all the sensory attributes of the RTS formulations. The addition of sugar syrup as per FPO specifications (1995) also led to a refreshing taste of the RTS formulated.

Aloe vera juice finds wide application in the production of food products (Ahlawat and Khatkar 2011). Wide range of *A. vera* based products has been reported in earlier studies. These include RTS drink, health drink, soft drink, laxative drink, *A. vera* lemon juice, sherbet, aloe sports drink with electrolyte, diet drink with soluble fiber,

hangover drink with B vitamin, amino acids and acetaminophen, healthy vegetable juice mix, tropical fruit juice with *A. vera*, *A. vera* yoghurts, *A. vera* mix for whiskey and white bread, cucumber juice with *A. vera*, *A. vera* juice using mint and ginger as ingredients, spiced papaya and *A. vera* based RTS (Ahlawat and Khatkar 2011; Grindlay and Reynolds 1986; Yadav et al. 2013; Ramachandran and Nagarajan 2014). This study is unique as it has utilized sweet lime to develop an *A. vera* based RTS blend.

The results depicted graphically in Fig. 2 clearly indicate that the variation V3 was the best formulation with respect to all the sensory attributes. Increase in acidity of the formulations may have led to decline in the sensory attributes during storage period. The development of bitterness due to increase in non volatile compounds like gingerol in ginger during storage may also have contributed to the declining sensory attributes. Kaushal et al. (2008) reported that decrease in ascorbic acid content and formation of furfural leads to deterioration of sensory attributes in RTS prepared from seabuckthorn. This may have also impacted the products developed in this study. Loss of volatile aromatic substances may have compounded the decrease in flavour. Similar findings have been reported by (Thakur and Barwal 1998; Jain et al. 2011).

Microbiological studies of the *Aloe vera* based RTS formulations

The microbial analysis of the *A. vera* RTS formulations were performed at 15, 30, 45 and 60 DAS. The variations prepared were free from any microbial growth till the end of storage period in terms of bacterial plate count. This indicates that the RTS can be stored without any microbial damage till 60 days. The products prepared had citric acid and KMS as preservative and were pasteurized during packing stage. This ensured absence of the microbial

Table 4 Effect of storage period on organoleptic attributes of *Aloe vera* based RTS formulations

Duration of storage (days)	Formulations			
	V1	V2	V3	V4
Appearance and color				
0 DAS	6.88 ^a ± 0.02	7.22 ^b ± 0.02	7.44 ^d ± 0.04	6.70 ^f ± 0.01
15 DAS	6.50 ^a ± 0.02	7.10 ^b ± 0.02	7.35 ^d ± 0.02	6.60 ^f ± 0.01
30 DAS	6.40 ^a ± 0.02	7.00 ^b ± 0.02	7.25 ^d ± 0.02	6.54 ^f ± 0.02
45 DAS	6.30 ^{ab} ± 0.02	6.90 ^{bc} ± 0.01	7.10 ^{de} ± 0.02	6.45 ^{fg} ± 0.02
60 DAS	6.20 ^a ± 0.02	6.50 ^b ± 0.02	6.90 ^d ± 0.01	6.33 ^f ± 0.02
Mouth feel				
0 DAS	6.55 ^a ± 0.02	6.22 ^b ± 0.03	7.11 ^c ± 0.05	6.77 ^d ± 0.03
15 DAS	6.40 ^a ± 0.02	6.10 ^b ± 0.03	7.05 ^c ± 0.03	6.50 ^d ± 0.04
30 DAS	6.35 ^a ± 0.02	6.00 ^b ± 0.01	6.85 ^c ± 0.02	6.35 ^d ± 0.01
45 DAS	6.30 ^a ± 0.02	5.80 ^b ± 0.03	6.70 ^c ± 0.02	6.24 ^d ± 0.02
60 DAS	6.24 ^a ± 0.02	5.70 ^b ± 0.05	6.60 ^c ± 0.02	6.10 ^d ± 0.03
Taste				
0 DAS	6.55 ^a ± 0.01	5.85 ^c ± 0.02	6.85 ^e ± 0.01	6.33 ^g ± 0.03
15 DAS	6.40 ^{ab} ± 0.02	5.70 ^{cd} ± 0.01	6.70 ^e ± 0.02	6.20 ^g ± 0.02
30 DAS	6.30 ^a ± 0.02	5.60 ^c ± 0.03	6.40 ^{ef} ± 0.05	6.10 ^{gh} ± 0.01
45 DAS	6.25 ^a ± 0.02	5.40 ^c ± 0.03	6.30 ^e ± 0.03	6.00 ^g ± 0.01
60 DAS	6.10 ^a ± 0.02	5.30 ^c ± 0.04	6.10 ^e ± 0.03	5.90 ^g ± 0.02
Flavor				
0 DAS	6.55 ^a ± 0.01	5.85 ^c ± 0.02	6.85 ^e ± 0.04	6.70 ^g ± 0.01
15 DAS	6.25 ^a ± 0.01	5.70 ^c ± 0.07	6.70 ^e ± 0.04	6.60 ^g ± 0.05
30 DAS	6.10 ^{ab} ± 0.04	5.60 ^{cd} ± 0.02	6.40 ^{ef} ± 0.02	6.30 ^{gh} ± 0.05
45 DAS	5.90 ^{ab} ± 0.04	5.40 ^{cd} ± 0.03	6.30 ^{ef} ± 0.04	6.20 ^{gh} ± 0.02
60 DAS	5.70 ^b ± 0.03	5.30 ^d ± 0.04	6.10 ^f ± 0.08	5.90 ^h ± 0.01
Overall acceptability				
0 DAS	6.35 ^c ± 0.02	5.27 ^b ± 0.02	6.95 ^e ± 0.02	6.80 ^g ± 0.04
15 DAS	6.20 ^c ± 0.02	5.22 ^b ± 0.05	6.75 ^e ± 0.03	6.50 ^g ± 0.04
30 DAS	6.10 ^{bc} ± 0.02	5.11 ^{ab} ± 0.07	6.60 ^{de} ± 0.05	6.30 ^{fg} ± 0.03
45 DAS	5.90 ^b ± 0.05	5.00 ^a ± 0.06	6.50 ^d ± 0.05	6.40 ^g ± 0.03
60 DAS	5.70 ^b ± 0.03	4.90 ^b ± 0.06	6.40 ^d ± 0.03	5.90 ^g ± 0.01

Each value is the mean of three independent samples. Mean values ± SD

Means followed by the same letters within each column were not significantly different. ($P < 0.01$ —Tukey test)

spoilage during storage. The results are in accordance with the findings of (Ramachandran and Nagarajan 2014).

Conclusion

The results of the present investigation provide an effective way of delivering the bioactive benefits of *A. vera* juice in a tasty and refreshing way to consumers. The study revealed that the variation V3 having *A. vera*:ginger:sweet lime:amla juices in the ratio (70:05:10:15) was the best formulation as per the sensory analysis and it also had highest contents of vitamin c. The storage studies indicate statistically significant variations in the physico-chemical parameters and

sensory attributes of all the formulations of the *A. vera* RTS blend. Utilization of sweet lime in mitigating the bitter taste of the *A. vera* juice has been successfully achieved in this study. This may be a novel option for consumers seeking soft drinks with health benefits. The storage studies indicate that the *A. vera* based RTS formulations can be stored up to 60 days at ambient temperature without any spoilage and retention of physico-chemical and the sensory properties at acceptable limits. The ingredients used in the present investigation were procured from local farmers of West Garo Hills District of Meghalaya. The development of RTS and juice processing may thus act as an important employment generating option for the rural population thriving on agriculture sector.

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