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Effect of storage on physicochemical, microbial analysis and sensory characteristics of diet guava squash

Wirkung der Lagerung auf physikochemische, mikrobielle und sensorischen Eigenschaften eines diätischen Guaven-Fruchtsaftkonzentrats

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Summary

Consumption of sugary drinks is linked with obesity, poor health, poor diet, and tooth decay. This study was conducted to evaluate the physicochemical, microbial analysis and sensory characteristics of diet guava squash prepared with the combination of two alternative sweeteners sucralose and saccharin under storage condition. The guava squash was transferred to sterilized 250 mL plastic bottles and stored for the period of 90 days at (30–35 °C) room temperature. The physiochemical parameters like titratable acidity, ascorbic acid, total soluble solids, pH, microbial activity and sensory evaluation were analyzed regularly after the time interval of 15 days during the entire storage period. Microbial load was also investigated for the consumption quality of diet drink. Statistically significant differences were noted between the internal comparisons of all physicochemical parameters. The Vitamin C and acidity of the squash decreased, whereas pH and TSS increased during storage. No microbial activity and spoilage loss was founded in diet squash during the entire storage period, this make squash acceptable for consumers. According to principal component analysis (PCA), the total variance analyzed was (81.22 %) from two main components, whereas the total variation from the first component (PC1) was 45.69 % and from second component (PC2) was 36.03 %. According to sensory parameters, guava squash product prepared with the combination of (50 % sucralose and 50 % saccharin) was considered to be the most acceptable product by judge's committee.

Keywords: Guava squash, sweeteners, storage, physicochemical analysis, microbial analysis, sensory, PCA

Zusammenfassung

Der Konsum von zuckerhaltigen Getränken ist mit Fettleibigkeit, schlechter Gesundheit, schlechter Ernährung und Karies verbunden. Eine Studie wurde durchgeführt, um Guaven-Fruchtsaftkonzentrat zu bewerten, der in Kombination von zwei alternativen Süßstoffen Sucralose und Saccharin hergestellt wurde. Das Guaven-Fruchtsaftkonzentrat wurde in sterilisierte 250 ml Plastikflaschen übertragen. Diese Probenflaschen wurden für den Zeitraum von 90 Tagen bei (30–35 °C) Raumtemperatur gelagert. Die physiochemischen Parameter wie titrierbare Säure, Ascorbinsäure, Gesamtlösliche Feststoffe, pH-Wert, mikrobielle Aktivität und sensorische Auswertung wurden regelmäßig nach dem Zeitintervall von 15 Tagen während der gesamten Lagerperiode analysiert. Die mikrobielle Belastung wurde ebenfalls untersucht. Statistisch signifikante Unterschiede wurden zwischen den internen Vergleichen aller physikalisch-chemischen Parameter festgestellt. Das Vitamin C und die Säure des Fruchtsaftkonzentrats sanken, während pH-Wert und der lösliche Trockensubstanzgehalt (TSS) während der Lagerung zunahmen. Es wurde kein mikrobielles Wachstum oder Verderb während der gesamten Lagerzeit festgestellt. Dies macht Fruchtsaftkonzentrate geeignet für den Verbraucher. Nach der Hauptkomponentenanalyse (PCA) betrug die Gesamtanalyse aus zwei Hauptkomponenten 81,22 %, während die Gesamtvariation von der ersten Komponente (PC1) 45,69 % und von der zweiten Komponente (PC2) 36,03 % betrug. Auf der Basis von sensorischen Parametern wurde das mit der Kombination von 50 % Sucralose und 50 % Saccharin hergestellte Guaven-Fruchtsaftkonzentrat als das annehmbarste Produkt des angesehen.

Schlüsselwörter: Guaven-Fruchtsaftkonzentrat, Süßstoffe, Lagerung, physikochemische Analyse, mikrobielle Analyse, Sensorik, PCA

Introduction

In recent years, the global market of functional foods and demand for healthy life among consumers is growing gradually (Patel et al., 2016). In term of area and production, guava fruit is the fourth most important fruit after citrus, banana and mango. Due to its climatic conditions, guava grown on large scale throughout Pakistan. This fruit is highly beneficial and a prolific bearer even without not much care. Despite this, guava fruit is a rich source of Vitamin C. Guava has been called "Poor man's apple and "Tropical apple" and the fruit consist of 50 % flesh portion, 20 % peel and seed core. This fruit contain 13–26 % dry matter, 74–84 % moisture, 0.8–1.5 % protein, ash 0.4–0.7 % fat and 0.5–1.0 % and the fruit is also a rich source of pectin (1.15 %) and ascorbic acid (299 mg/100 g). Guava fruits has a considerable number of minerals such as calcium (15–31 mg-100 g), iron (0.5–1.5 mg/100 g) phosphorus (24–38 mg/100 g) and vitamins like thiamine, riboflavin, niacin and vitamin A (Paull and Goo, 1983) (Bose and Mitra, 1999). With the change of time, consumers demand and attitudes change. Developments of products in the market has been indispensable for producers to develop new products, which have more health benefits and nutritional values. In this context, this fruit has admirable amount of nutritive and digestive values, high palatability, pleasing flavor, and easy access in the market at reasonable price. As guava fruit contain high moisture content, due to this, its shelf life is very short of one week (Singh et al., 1990). Post-harvest losses also high about 22 % (Bons and Dhawan, 2006). Guava fruit used in the preparation of by products like juice, jam, jelly, pulp, nectar, dehydrated products and fruit bars while this fruit also be consumed as fresh fruit, moreover this fruit can be used as value added for other fruits in juices and pulp's (Leite et al., 2006). The processing of fruits into different products is a good way to reduce post-harvest losses (Pandey and Singh, 1998, Sandhu et al., 2001). During the peak season of guava, it losses increase in handling of the fruit. The best way to reduce these losses is to preserve guava fruit into guava squash, which is very delicious and acceptable to consumers.

Non-nutritive sweeteners can reduce the problems with tooth decay, cardiovascular diseases, obesity and other health related problems that are cause by the high consumption of caloric sweeteners like sucrose (Cardello and Damásio, 1997). In Pakistan and China, the use of non-nutritive sweeteners is not too much, but use of these sweeteners is economical and also helpful in controlling sugary related diseases like obesity, etc. A number of non-nutritive sweeteners are available in markets like sucralose, saccharin, cyclamate, aspartame, acesulfame-K and stevia etc. These alternative sweeteners not absorbed by the body and do not give any energy, calories or contribute to the body. The use of alternative sweeteners can improve nutritional value, when consumers used non-nutritive sweeteners for the utilization of nutrient dense foods (Association, 2004). The use of alternative sweeteners like aspartame, acesulfame-K and saccharin in Danish society is lower than the daily dietary intake(Leth et al., 2007). A recent research of nationwide diet surveys specifies that American people specially adults who consume low caloric sweeteners products have much better health than those who do not consume alternative sweeteners (Sigman-Grant and Hsieh, 2005). Broad technical study determined the safety of non-nutritive sweeteners and is now allowed to be consume in the United States (Kroger et al., 2006). In non-nutritive sweeteners, sucralose is safe in use, more sweet, poorly digestible (600 times sweeter than sucrose) having no bitter aftertaste, reliable at room temperature and outstanding stability in acidic products which make it perfect sweetener for both beverages and consumers (Jenner, 1989, Horne et al., 2002, Kuhn et al., 2004, Grotz and Munro, 2009).

In developed countries, non-nutritive sweeteners are used for the preparation of certain products to reduce calories but use of these sweeteners are limited and now the trend is changing towards these artificial sweeteners. Keeping in view all these facts, this study was done to replace sucrose with artificial sweeteners (sucralose and saccharin) completely to prepare diet guava squash. Thus, this research was based on the selection of suitable sweetener for the preparation of diet squash that can replace sugar partly or wholly. Moreover, the impact of sweeteners alone and in blends was evaluated on the basis of organoleptic, spoilage and microbial analysis and physicochemical properties of diet squash.

Materials and methods

Fully mature, fresh, ripened and uniform size guava fruits and other material like sucrose, saccharin and sucralose were purchased from local market. Fruits were washed in tap water to eliminate surface dirt and dust.

Preparation of squash

Guava squash samples were prepared from guava pulp, pasteurized at 80 °C for 5 minutes for the inactivation of microorganisms with the addition of water, sugar and alternative sweeteners. These samples were prepared by the standard formula 3:1:4. Citric acid (1 %) was used to maintain the product acidity whereas (0.1) potassium metabisulphite (KMS) was used in the entire samples as chemical preservatives. All remaining samples were prepared by above formula while sucrose was replaced by alternative sweeteners. Detail of treatments is under (Symbol "T" specifies treatments number).

T_0 = Sugar 100 % (Controlled sample)
T_1 = Sugar 50 % + Saccharine 25 % + Sucralose 25 %
T_2 = Saccharine 100 %
T_3 = Sucralose 100 %
T_4 = Saccharine 50 % + Sucralose 50 %

Packaging and storage of squash

All guava squash samples were packed in 250 mL plastic bottles. After packing, the squash product was stored at room temperature (30 °C ~ 35 °C) for a storage period of 90 days. Physicochemical parameters, microbial analysis and sensory analysis were done regularly after each 15 day.

Quality evaluation (Physicochemical evaluation)

TSS: A TSS values of all samples was noted by handheld refractometer. Two different refractometer with different ranges were used for this analysis such as (model no. 91706, Shibuya, range 0 ~ 32 and model no. 8792, Fuji Koki LTD, Japan, range 28 ~ 62) In each treatment, three values were noted and results were expressed in °Brix.

Titratable acidity %

It's the acidity of the product to find a dominant acid in squash, i. e. citric acid. Titratable acidity was determined by the method explained by (Ranganna, 1986). It can be measured by taking 10 ml of the sample by adding 3–5 drops of 1 % phenolphthalein as an indicator and titrated with 0.1 N NaOH solution. Titratable acidity was calculated by following formula

$$\text{Total acid \%} = \frac{\text{Titre x Equivalent acid weight}}{\text{Sample taken volume x 1000}} \text{ x 100}$$

Ascorbic acid content (Vitamin C)

The titrimetric method was used for the determination of ascorbic acid. In detail, 5 ml of 3 % metaphosphoric acid soltion, 5 ml of squash sample and 5 ml of standard ascorbic acid solution were titrated against (0.025 %) of 2–6 dichlorophenol-indophenol solution till the pink color appears. All squash samples were repeated thrice (AOAC, 1990).

pH

The pH of guava squash samples was examined by using a digital pH meter (3020, Jenway, UK) (AOAC, 1990).

Spoilage and microbial analysis

During the whole storage period, the growth of the mold was observed visually by the prepared product and for the analysis of microbial load of diet guava squash, it was determined by analyzing bacterial and fungal growth in the prepared product by the method described by (Kadam et al., 2012) with some modifications.

Organoleptic evaluations

Standard organoleptic evaluation process was performed to determined descriptive analysis; a number of 10 trained panelists were served diet squash samples in randomized order at room temperature. Judges committee consist of 6 male and 4 female judges. Judges ages varied from 38 to 46 years. For checking the appearance of guava squash, samples were kept in 100 ml beaker while RTS squash was served in transparent glasses. Taste, after taste, appearance and flavor were assessed after each 15 day till 90 days of the storage period. For scoring of guava squash a 9-point hedonic scale method was used as described by (Larmond, 1977).

Statistical analysis

Physicochemical analysis, microbial analysis, sensory evaluations were executed to analyze the effect of treatments and storage on the quality of food safety. All data was analyzed by using Two-way ANOVA (DMR Test, significant $P<0.01$) SPSS ver. 16.0 statistical software package (SPSS Inc. USA) in three replicates. The experimental groups were then separated as described by (Robert et al., 1997). Principal component analysis (PCA) was utilized to examine the correlation between diet guava squash samples and storage period (0, 15, 30, 45, 60, 75, and 90 days.) using SPSS ver. 16.0 statistical software package (SPSS Inc. USA).

Results and discussion

Effect of treatments and storage time on ascorbic acid

In this study, the ascorbic acid contents showed significant ($P<0.01$) decrease with the passage of time in all treatments compared to control as an evident from (Tab. 1). The results of statistical analysis show highly significant for the storage period (Tab. 2). These losses in ascorbic acid is due to storage conditions like room temperature and light exposure. The exposure of light was found to endorse browning in guava squash, so in this manner, the longer the light exposure, the higher will be the loss of ascorbic acid (Altaf et al., 2006). Non-tropical areas fruits contains high level of vitamin C, while hot tropical areas fruits contain low vitamin C level and high temperature affects the amount of Vitamin C in fruits (El-Ishaq, A. and Obirinakem, S. 2015).

TABLE 1: *Effect of treatments on physiochemical characteristics of diet guava squash.*

Treatments	Physicochemical analysis			
	AA	TSS	pH	Total acidity
T_0	7.53a	49.83a	4.33a	0.0057a
T_1	6.87b	31.77b	4.30b	0.0068c
T_2	6.57c	5.28d	4.25d	0.0056d
T_3	6.81b	5.58c	4.30b	0.0058b
T_4	6.52d	4.40e	4.26c	0.0058b

The loss in ascorbic acid may be due to the aerobic and anaerobic pathways (Ahmed et al., 2008). Numerous chemical reactions take place to the loss of ascorbic acid, which can lead to the chemical deterioration of fruits (El-Ishaq, A. and Obirinakem, S. 2015). Most of these reactions are enzymatic, while other chemicals reactions are due to aging (El-Ishaq, A. and Obirinakem, S. 2015). This involves changes in color, taste and odor, caused by chemical reactions between fruits components. The biochemical reactions occurring during storage and microbial effects in all squash samples lead to changes in pH. Vitamin C was promptly oxidized thus, the utilization of metaphosphoric acid and acetic acid to inhibit metabolic activity in cell division and protein perception. It can be concluded from the results that the lower the temperature, the higher the availability of vitamin C in squash. It is ideal to keep up or store beverages containing vitamin C in a place below the room temperature. Similar results were also revealed by (Pandey, 2004, Kumar et al., 2008) in guava beverage, mango nectar, nectar preparation from guava varieties and storage stability of jamun fruits, respectively.

Effect of treatments and storage time on total soluble solids (TSS)

The TSS of diet guava squash was increased during three months of storage periods (Tab. 1). The interaction between storage intervals and treatments was found non-significant whereas storage intervals and treatments were significant. Retention or minor increase in soluble solids of diet guava squash during storage was desirable for maintaining guava squash quality (Tab. 2). This increase in the TSS of diet guava squash was mainly due to the conversion

TABLE 2: *Effect of storage interval on physiochemical characteristics of diet guava squash.*

Parameters	Storage intervals (days)						
	0	15	30	45	60	75	90
AA	7.35g	7.11f	6.97e	6.85d	6.75c	6.55b	6.45a
TSS	19.08g	19.18f	19.28e	19.46d	19.66a	19.49c	19.51b
pH	4.24g	4.26f	4.27e	4.28d	4.31c	4.33b	4.34a
Total acidity	0.0064g	0.0063f	0.0062e	0.0060d	0.0058c	0.0056b	0.0054a

of left over polysaccharides into soluble sugar one and formation of water soluble pectin from protopectin. Another reason of increasing total soluble solids in diet guava squash during storage might be due to the hydrolysis of polysaccharides into monosaccharides and oligosaccharides (Bhardwaj and Mukherjee, 2011). In our study, the soluble solids content was increased during storage at 80 °C treatment temperature with the addition of KMS. This may be due to the fact that guava squash examine microorganism's growth, otherwise, there will be higher TSS due to higher metabolic rates. Comparable results were likewise reported by (Deka and Sethi, 2001) in mango juice mixes. In addition, KMS resulted in the decrease of hydrolysis polysaccharide yield and finally decreased the soluble solid content. Similar results has been reported in the preservation of litchi juice (Cecilia, 1985) mixed juice and kinnow (Bhardwaj and Mukherjee, 2011). The same results were also revealed by (Pandey, 2004, Mall and Tandon, 2005, Kumar et al., 2008) in storage stability of guava squash, guava anola blend drink, nectar preparation from different guava varieties, musambi RTS beverage, drink from stored guava pulp, respectively.

Effect of treatments and storage time on pH

It plays a very important role in maintain shelf life of product. pH also can influence the flavor and process needs of beverages. The data of pH is presented in (Tab. 1) which shows variations in treatments and control samples. An increasing trend was observed in all samples during storage periods (Tab. 2). This increase due to the influence of temperature. The outcomes exhibited here, in concurrence with a few prior reports, demonstrate that pH of diet guava squash increase with the decrease in titratable acidity as fruit ripening prolongs. Fruit juices having low in pH values was mainly due to this because they are rich in organic acids (Tasnim et al., 2010, Kumar et al., 2012) Observed pH in 120 days of storage in guava mixed aloe vera and Roselle juice temperature increased significantly. The decrease in the acidity of the product during storage may be due to the changes in the pH value. The difference in pH within different treatments was because of different ionic activity of the sweeteners used (Anthon et al., 2011).

Effect of treatments and storage timeon titratable acidity

Acidity is an important factor in the term of tartness. Sourness of the product is mainly due to the acid (Ahmed et al., 2008). All diet guava squash samples were analyzed for titratable acidity and decreased was observed in all samples. This decrease of acidity is shown in (Tab. 1). A slow and constant decline in titratable acidity was observed in the diet guava squash. This may be because of the chemical interactions between the organic components of the squash actuated by temperature and activities of enzymes were accounted by (Kumar 2009, Nath et al., 2005). The decrease in acidity may likewise because of hydrolysis of polysaccharides and non-reducing sugars where corrosive is used for conversion it into reducing sugars. Comparable outcomes were accounted by (Gajanana, 2002) in amla juice. This decrease may be due to increase in the pH and temperature gradient of diet guava squash (Tab. 2). The interaction between storage days and treatments were non-significant. (Kumar et al., 2008, Bal et al., 2014) also finds similar results of decreasing acidity in their study. Loss of acidity was reported in watermelon jam (Bhatnagar, 1991). (Thakur and Barwal, 1998) noted decline in titratable acidity in kiwi fruit. Decrease of acidity was revealed by (Mehta et al., 2005) in candy and loss of titratable acidity was noted by (Singh et al., 2005) in baltimore and papaya jam.

Effect of treatments and storage time on spoilage and microbial load

Non-nutritive guava squash was free from microbial decay during storage, due to addition of KMS as a preservatives and inactivated microorganisms by heat treatment. Guava squash had higher soluble solids, which may prevent microbial growth by reducing the effectiveness of free water. Comparative perceptions were additionally reported by (Roy and Singh, 1979) in passion fruit juice and in baltimore tea, respectively. Microbial load of the diet guava squash was identified thorough checking fungal and bacterial growth in all samples for the safety of consumers. (Kadam et al., 2012) reported that there was no bacterial and fungal growth was detected in the developed guava fruit juice.

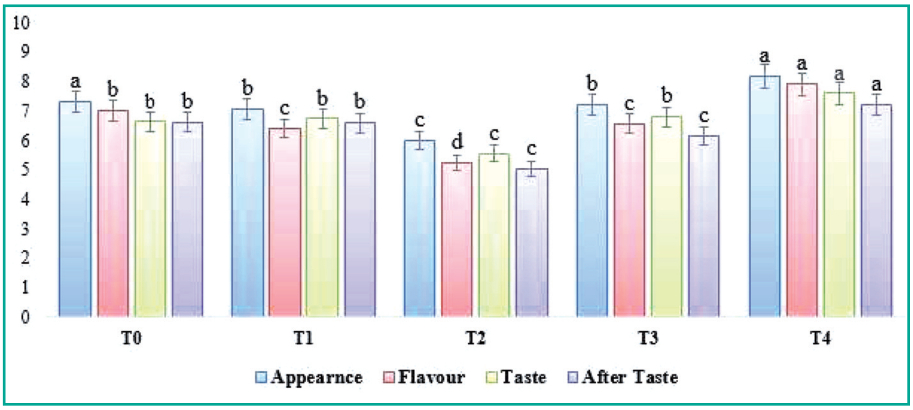

FIGURE 1: *Effect of treatments on physiochemical characteristics of diet guava squash.*

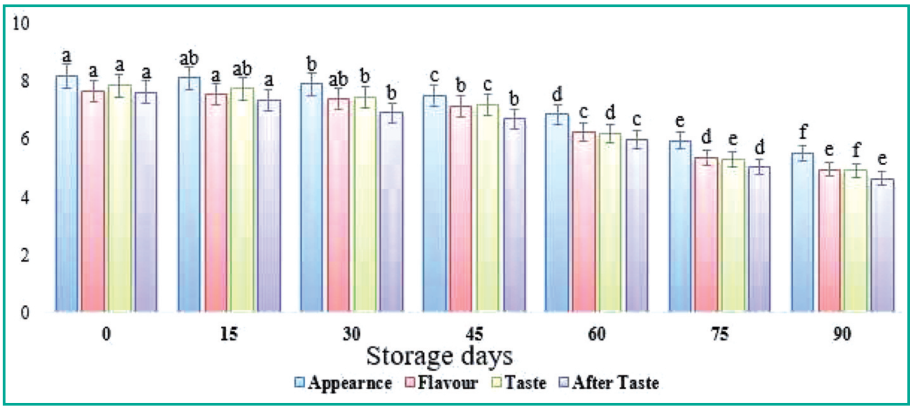

FIGURE 2: *Effect of storage on physiochemical characteristics of diet guava squash.*

Sensory evaluations

Effect of treatments and storage time on appearance

The effect of treatments on appearance of diet squash is presented in (Fig. 1). T_4 was the highest score in appearance among all other treatments followed by T_0 and T_3. Lowest appearance score was noted in T_2. Interaction between treatments and storage are non-significant. Statistically significant decrease was noted ($P<0.01$) in means of treatments and storage days. A maximum appearance score of all treatments were noted when squash was freshly prepared, afterwards gradual loss was noted with the increase in storage period. The gradual loss in the entire storage period is presented in (Fig. 2). This loss in appearance score may be due to acid present in diet squash (Bhardwaj and Mukherjee, 2011). Similar results were also noted by (Ahmed et al., 2008) in his study of mandarin diet squash.

Effect of treatments and storage time on taste

In organoleptic evaluation, taste is a very important factor after flavor and appearance. In taste score, T_4 which was high in score among all other treatments that were prepared with the combination of sucralose and saccharin, it was followed by T_3 and T_1. It was observed that diet squash which was prepared with the combination of sweeteners (sucralose and saccharin) was more acceptable than others. Single sweetener like sucralose was also acceptable after blends of sweeteners because in combination/blends saccharine bitter taste was masked by sucralose but single sweeteners like saccharine was not acceptable, according to judges because of its bitter taste (Fig. 1). Interaction between treatments and storage interval are non-significant. As the storage period increase, taste score decrease in all treatments as shown in (Fig. 2). This loss in taste may be due to volatile compounds in diet squash (Ahmed et al., 2008). The difference in taste and decrease in storage periods was due to temperature, similar results were also reported by (Jain et al., 2003)

Effect of treatments and storage time on flavor

Flavor is a mixture of taste and smell, and is judged to be food in the mouth. The general sense of flavor is the result of taste in the mouth, taste buds, and aromatic compounds found in the nose (Rathore et al., 2007). In diet guava squash flavor was significantly affected by treatments (Fig. 1). T_4 got higher score while T_0 got lower score in all treatments. Interaction between treatments and storage interval are non-significant. During various storage levels, significant variations of flavor perception was observed in diet guava squash. The higher score of flavor was noted in all treatments when diet squash was freshly prepared, afterwards with the increase in storage periods flavor score slightly decrease continuously till 90 days of the storage period (Fig. 2). The results are consistent with those of (Tasnim et al., 2010) who concentrated the impact of capacity and cultivars on overall acceptability and quality of mango squash and furthermore examined that the quality parameters like quality and color declined during storage. The flavor decreases as time increase during storage. This loss in storage period is mainly due to the presence of the volatile compound in squash drink. Flavor loss also reported by (Mall and Tandon, 2005, Kumar et al., 2008, Bal et al., 2014) during their studies in guava anola blend beverage, musambi drink, preparation of guava nectar from different varieties and guava nectar.

Effect of treatments and storage time on after taste

Aftertaste score of diet guava squash is presented in (Fig. 1). The score of aftertaste was first noted when diet squash was freshly prepared. Among all treatments T_4 (sucralose and saccharin) got higher score according to judges because of no aftertaste, while control samples T_0 also got high scores after T_4. Highly bitter aftertaste was noted in T_2 which was prepared by single sweetener saccharin and rejected by judges. Decrease in score of the storage period was noted from 0 days to 90 days as shown in (Fig. 2). This decline in storage was due to room temperature. Same kinds of results were also revealed by (Paracha et al., 2009).

Principal Component analysis (PCA)

Principal component analysis (PCA) is a method of identifying patterns in data, which represent data by highlighting their similarities and differences (Winterová et al., 2008) PCA modeling perfectly explains the variances between common variables. It has been previously used to establish the interactions between mango-mandarin squash samples and quality parameters during storage (Shahid, 2015). After the statistical analysis of all data, the PCA display two main components (PC), which clarified 81.22 % of the total variance. The score plots produced using PCA of diet guava squash tests in storage are appeared in (Fig. 3a) and the appropriation of quality parameters characterized by the first and second PCA measurements were displayed in

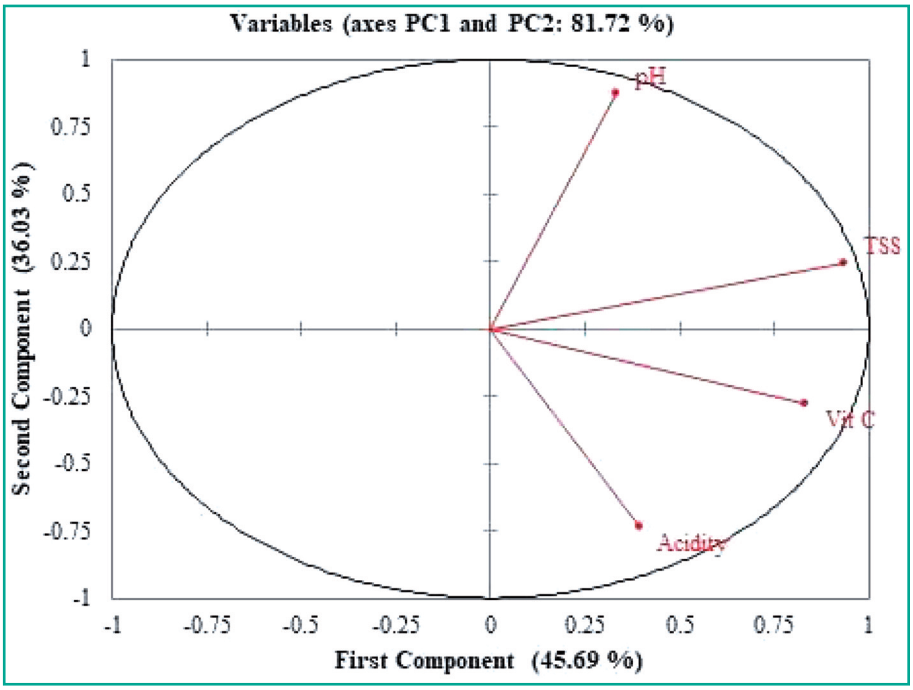

FIGURE 3A: *Variables of quality parameters.*

(Fig. 3b). The total contribution of principal component PC1 and PC2 was 81.72 % of variance in non-nutritive guava squash samples. The total variation from the first component (PC1) was 45.69 % and the total variation from second principal component (PC2) was 36.03 %. From the (Fig. 3), it has been clearly shown that first principal component is positively correlated pH, TSS, Vitamin C, and titratable acidity.

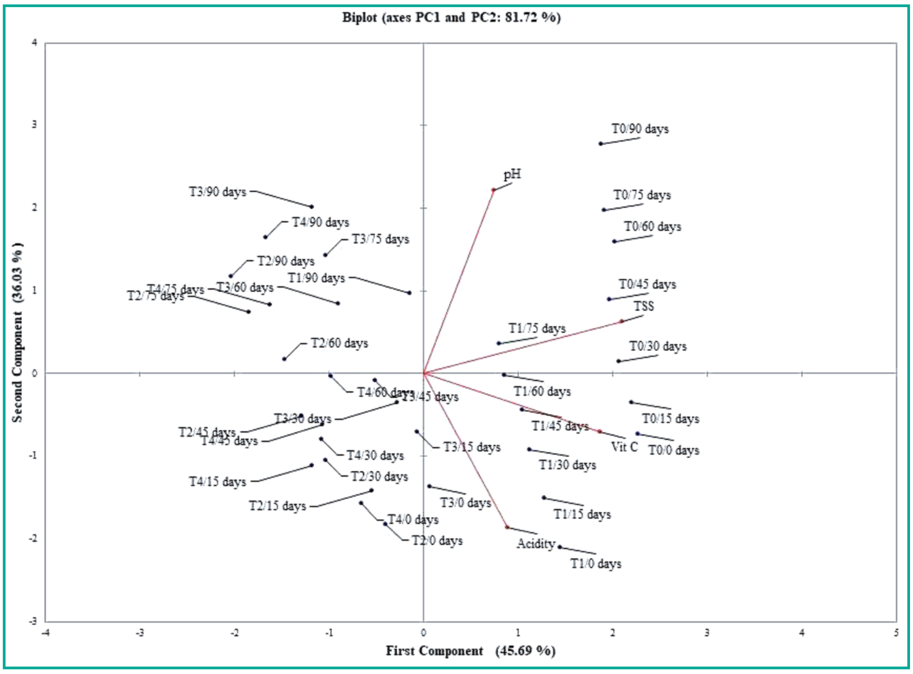

FIGURE 3B: *Biplot of principal component analysis (PCA) between storage and treatments.*

Correlations between variables

Correlations were found in a set of 4 physicochemical characteristics of diet guava squash (Table 3). TSS was significantly correlated with Vitamin C (r = 0.755) and pH (r = 0.4948). In general, TSS was positively correlated with Vitamin C, pH and titratable acidity, but the correlation was not significant. Vitamin C negatively correlated with pH (r = –0.0691). A non-significant and positive correlation was observed between pH and TSS (r = 0.4948), while negative correlation were noted with Vitamin C (r = –0.069) and titratable acidity (r = –0.3333). In addition, there were no significant correlation of titratable acidity was found with other attributes like Vitamin C, pH, and TSS, although negative correlation was noted with pH (r = –0.3333).

In general, the correlation coefficients of variable in non-nutritive guava squash were evaluated. The present study showed that the physicochemical attributes of diet guava squash tested can be improved.

Conclusion

Since value added and product diversification is particularly in the current market scenario. Loss of vitamin C with time varies from one fruit to other under comparable storage situations. While the heated samples lead to significant loss of vitamin C in fruits. For instance, fruit handling, boiling, storage conditions and oxygen is the most damaging components in squash, and should be avoided at hot weather over room temperature to maintain production levels. A wide range of diversified products such as diet guava squash is very important. Minor changes were observed in physiochemical analysis, but these changes not affect the quality of diet guava squash. Among all treatments T_4 (sucralose and saccharin) was considered to be the best treatment in term physiochemical and sensory parameters.

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TABLE 3: *Pearson's coefficient of correlation matrix.*

Variables	TSS	vitamin C	pH	acidity
TSS	1			
vitamin c	**0.6367**	1		
pH	**0.4948**	–0.0691	1	
acidity	0.2014	0.2976	–0.3333	1

Values in bold are different from 0 with a significance level alpha = 0.05

Conflict of interest

The authors declare no conflicts of interest.

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