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DEVELOPMENT AND STORAGE STUDIES OF GUAVA-CHIKU BLENDED FRUIT LEATHER

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A B S T R A C T

The study was carried out on the preparation and storage stability of guava-chiku blended fruit leathers. Guava and chiku pulp was blended in the ratio of 100:0, 90:10, 80:20, 70:30, 60:40 and 50:50 respectively to prepare blended leathers. The samples were stored at room temperature, and the quality was evaluated periodically in consideration with physicochemical and sensory attributes at 15 days interval during storage period of 90 days. Significant decrease ($P<0.05$) was observed in moisture (18 to 15.3%), water activity (0.635 to 0.583), pH (3.84 to 3.64), non-reducing sugar (3.58 to 3.23%) and ascorbic acid (89.93 to 81.01 mg/100gm). Increase ($P<0.05$) was observed in acidity (1.20 to 1.40%), total soluble solids (68.59 to 73.01 ^{o} Brix) and reducing sugar (16.76 to 17.45%). The sensory attributes of the leather were also affected significantly ($P<0.05$) by storage period. Mean score for color decreased from (7.81 to 5.50), taste (7.50 to 5.58), texture (7.83 to 5.46) and overall acceptability (7.71 to 5.53). The overall results showed that the leather prepared by 50:50 combination of guava and chiku pulp shows better stability in terms of physicochemical as well as sensory quality attributes.

Keywords: Blended Fruit Leather; Chiku; Guava (*Psidium guajava*); Storage and Development

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INTRODUCTION

Guava (*Psidium guajava*) is a famous fruit of Myrtaceae family grown in most tropical and subtropical areas of the world (Pervaiz et al., 2008). Guava is a highly nutritious fruit. It has prime importance regarding vitamin C and A, with seeds that are rich in omega-3, omega-6 polyunsaturated fatty-acids and specialty fibers (dietary), vitamin B_2, some proteins, and minerals like iron, calcium, potassium. The highest content of vitamin-C in guava makes it a power-plant in preventing free radicals and oxidants that are key opponents that cause many chronic diseases. The anti-oxidative probity in guavas is assumed to help decrease the risks of cancer of stomach, larynx, esophagus, pancreas and oral cavity (Kadam et al., 2012). The fruit in fresh form has a short shelf life, so it is very necessary to utilize the fruit for making various processed products in order to enhance its availability for a longer period and to stabilize the price during the glut season. Guava could be used fresh, or it can be processed into jam, jelly, juice, pulp, nectar, different slices in syrup, fruit bar and dehydrated products, also it is used as a supplement to other fruit juice or pulp (Leite et al., 2006).

Chiku (*Achras sapota*) is a major crop of the Sapotaceae family originated from Central America. It is also known as sapota or sapodilla. The fruit is oval shaped having about 10 cm diameter and 150 gm weight normally. Sapota fruit has a thin rusty brownish skin and brown or red pulp with a sweet and amiable taste (Thompson, 2008). India is the largest producer of sapota fruit having 162 thousand hectare land cultivated by sapota and produces 1358 thousand ton sapota per year (FAO, 2020). Pakistan produces about 6.7 thousand ton chiku over an area of 1.7 thousand hactares. Sindh is the

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leading producer of the chiku fruit in Pakistan, which have an area of 1.8 thousand hactares land cultivated with chiku and produces an average of 3.9 thousand ton annually (Ministry of National Food Security and Research Pakistan, 2015). Chiku is a nutritious fruit composed of carbohydrate (up to 21%), protein (0.8 gm/100 gm), fat (1.1 gm per 100 gm), calcium (28 mg per 100 gm), phosphorus (27 mg per 100 gm), iron (2 mg/100 gm), vitamin C (6mg per 100 gm), glucose (5-9 %), fructose (4.4-7.1%), sucrose (1.4-8.5%), starch (2.8-6.4%), tannins (2.1-6.4%) and moisture (73%) (Balerdi et al., 2005).

Fruit leathers are the dehydrated confectionery type fruit based products. They mostly come in flexible sheeted or strips form. As the final texture of the product is shiny and looks like leathers so it is called leathers (Natalia et al., 2011). Leathers can be made from a variety of fruits; the most common being apple, apricot, mango, banana and tamarind. They can also be made from mixtures of fruits. They are used as snack food or confection and provide basic nutrition to consumers. They can also be used as an ingredient in various food products like cakes, desserts, cookies and various ice creams. They are intermediate moisture food products having moisture of 15-25%. The preservation is dependent upon the moisture content, sugar content and the acidity content of the fruit used (FAO, 2015). Pulpy fruits can be easily processed into fruit bars while the juicy fruits cannot be used as such for bars production and so the thickeners and stabilizers like pectin, carboxy methyl cellulose (CMC), starch and maltodextrin should be added to such fruits for achieving the best and stable fruit bars (Vijayanand et al., 2000). Fruit leathers have gained considerable popularity in the last decades because these products contain more vitamins and minerals, and are much healthier than other confectioneries and snack foods (Naz, 2012). The fruit bars have reflected a good food from health point of view as compared to former confectioneries and candies. They have acids and sugars inherently, while humectants are added willingly so that to minimize water activity and produces a soft product even at low moisture content (Torley et al., 2005).

MATERIALS AND METHODS

Leather preparation

Guava and chiku fruits with optimum maturity and uniform size were procured from the local market of Peshawar, and were brought to the laboratory of "Department of Food Science and Technology" the University of Agriculture, Peshawar. The fruits were washed with clean water to remove dust, dirt and other foreign matter to ensure safety. The peels and internal seeds were removed and then the fruits were passed through a pulping machine to achieve pulp of both fruits.

The method of Chavan et al. (2016) was used for the preparation of blended leathers. The extracted pulp was mixed in different proportions for making treatments as 100:0, 90:10, 80:20, 70:30, 60, 40, and 50:50 guava and chiku, respectively (Table 1). Then sugar (10%) and citric acid (0.3%) were added to all the treatments. It was heated on a low flame for few minutes and the pectin (already mixed with powdered sugar) was added with slow sprinkling and continuous stirring in order to inhibit lumps formation and burning. After it became a little concentrated, the puree was then transferred to stainless steel trays which had already been smeared with oil, and spread in 10 mm thick layers. The puree was then dried in hot air electric oven at 60^{o}C for 12 hours. After proper drying, it was then cut into rectangular cubes of 2.5cm×6cm size. The prepared leathers were then packed in zipped polythene bags and stored under cool, dark and dry place for analysis.

Table 1. Treatments combination.

Treatment ID	Guava pulp	Chiku pulp	Sugar	Pectin
T_0	100%	0%	10%	2%
T_1	90%	10%	10%	2%
T_2	80%	20%	10%	2%
T_3	70%	30%	10%	2%
T_4	60%	40%	10%	2%
T_5	50%	50%	10%	2%

Physicochemical analysis

The prepared leather samples were analyzed for physicochemical parameters (moisture, pH, acidity, TSS, water activity, reducing sugar, non-reducing sugar, ascorbic acid) at 15 days interval for a period of three months.

Sensory analysis

The leather samples were evaluated for sensory attributes (color, taste, texture, overall acceptability) by presenting it to a panel of 10 judges using the method of Larmond (1977).

Statistical analysis

The data were analyzed by using analysis of variance in Completely Randomized Design (CRD) with two factorial arrangements as defined by Steel et al. (1997). Statistix 8.1 software was used for statistical analyses in this research. Significance was defined at $P \leq 0.05$.

RESULTS AND DISCUSSION

Physicochemical analysis of fresh fruit pulps

The physicochemical composition of pulps of both fruits (guava and chiku) is shown in table 2.

Physicochemical analysis of prepared leather

Figure1 revealed results for pH of guava-chiku blended leather as affected by storage and treatment (pulp ratio). pH showed a slight decreasing trend during storage period, while it increased treatment-wise as with subsequent addition of chiku pulp to the formulation; this owed to the higher pH of chiku fruit (Table 2). Mean values for storage period decreased significantly ($P<0.05$) from 3.84 to 3.64. Maximum decrease occurred in T_0 while minimum in T_5 (Figure 1). Our results are similar to Sawant and Patil (2013) who reported that the pH of guava-sapota jam increased with the regular addition of sapota pulp to jam formulation. Similarly, a decrease in pH during storage was detected by Khan *et al.*, (2015) in blend guava- apple leather, and by Shakoor et al. (2015) in guava bar during storage. Phimpharian et al. (2011) also reported a reduction in pH of pineapple leather during storage. The decreasing trend in pH might be payable to the development of free acids, hydrolysis of pectin and also from ascorbic acid degradation.

Table 2. Physicochemical composition of pulp of guava and chiku fruits.

Parameter	Composition	
	Guava	Chiku
pH	3.95 ±0.23	4.98 ±0.31
Acidity	0.40 ±0.19	0.29 ±0.24
TSS	8.5 ±0.54	19.6 ±0.41
Moisture	83.4 ±0.65	71.5 ±0.33
Water activity	0.93 ±0.16	0.9 ±0.25
Non-reducing sugar	2.6 ±0.34	4.3 ±0.45
Reducing sugar	3.6 ±0.64	8.3 ±0.72

All values are mean (±SD) of three replications.

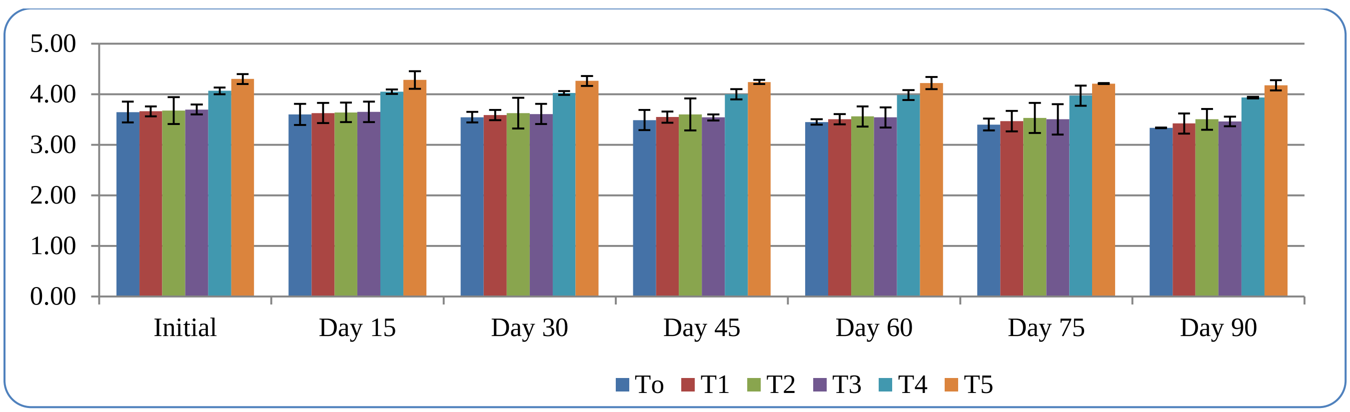

Figure 1. pH of guava-chiku blended leather as affected by storage and treatments. The values are means of three replications (SD±).

Figure 2 revealed acidity of guava-chiku leather as affected by storage duration and treatments (pulp ratio). Acidity of the leather showed an increase during storage period while it is inversely affected by treatments; decreased as the chiku is added subsequently. The increase across treatments is due to the lower acidity level and higher pH level of the chiku fruit (Table 2). For storage, the mean values increased significantly ($P<0.05$) from 1.20 to 1.40. Maximum increase was observed in T_0 while minimum been observed in T_5 (Figure 2). The results are similar to Parmar (2008) who

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derived similar results while evaluating guava-papaya blend leathers. The finding of our research are also matching with Khan et al. (2014) who resulted an increase in acidity in guava-apple blend leather during storage. Addo et al. (2013) also deducted similar rising of acidity in mango leathers during storage. The increment in acidity may be due to the addition of the citric acid to fruits puree, and drying process also concentrated the natural acidity of the fruit as a result of which it is occurred. The increment in the acidity during storage might also be due to breaking down of pectin into pectenic acid.

Moisture of guava-chiku leather after storage and treatment is given in Figure 3. Moisture showed significant decrease during storage, and also it decreased as the chiku concentration increased; this owed to lower moisture level of chiku fruit (Table 2). Mean values for storage decreased significantly ($P<0.05$) from 18.0 to 15.30 after 3 months. Maximum decrease observed in T_1 while minimum in T_4 (Figure 3). Our results are similar to that of Chavan et al. (2016) who reported a similar decrease in moisture content of mango-sapota (chiku) mix leathers with step by step addition of mango and sapota pulps. Shakoor et al. (2015) also found decrease in moisture content of guava bars during storage. Safdar et al. (2014) also reported that there is decrease from in moisture content of guava leathers during storage. Uzma et al. (2014) analyzed that there is significant decrease in moisture content of the leathers made from apple during storage period. Moisture is a very important factor in food products. It affect the sensory quality of food as texture, taste and appearance, and also have effects on the shelf life of food products, and is generally used as an indicator of shelf life of foods.

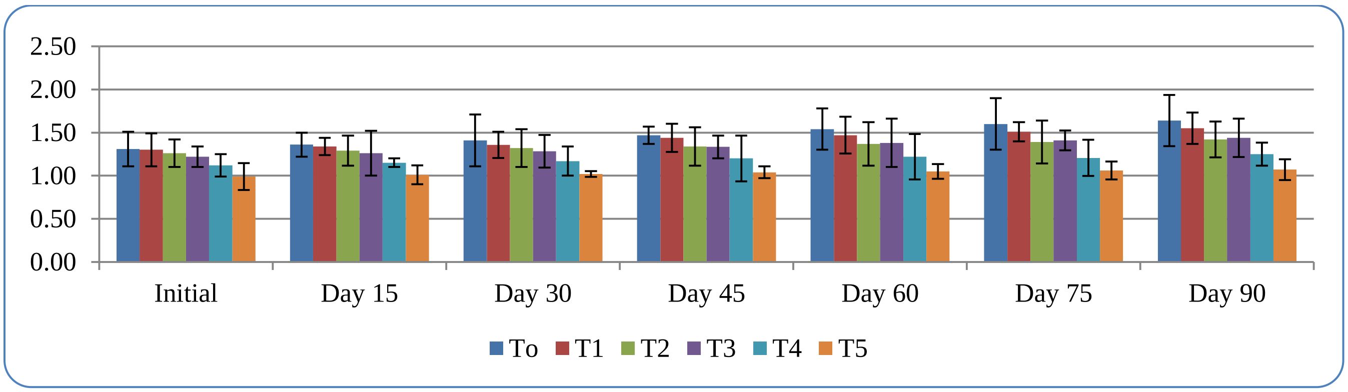

Figure 2. Acidity of guava-chiku blended leather as affected by storage and treatments. The values are means of three replications (SD±).

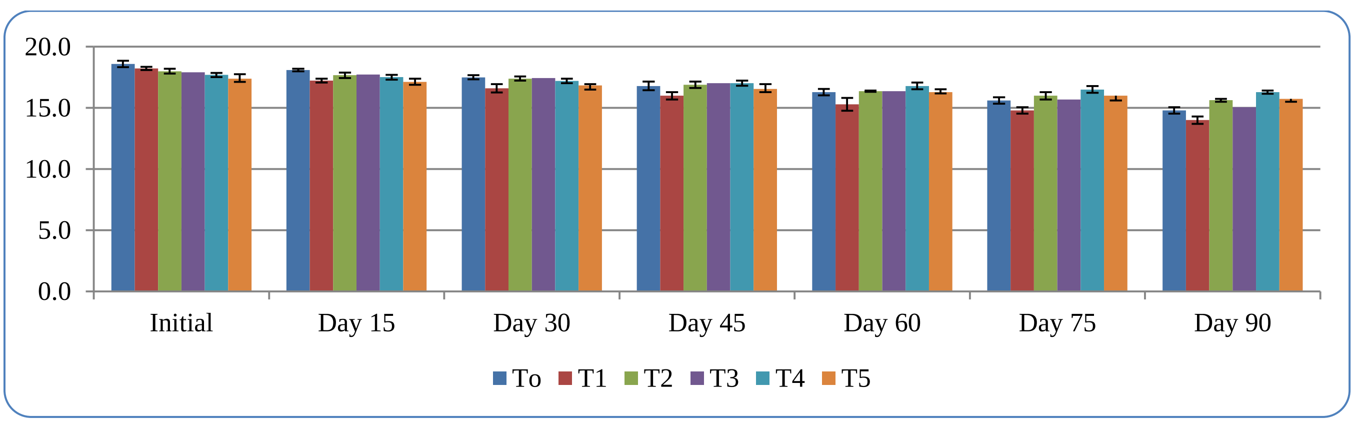

Figure 3. Moisture of guava-chiku blended leather as affected by storage and treatments. The values are means of three replications (SD±).

Figure 4 revealed results regarding total soluble solids. It is evident that TSS is affected by storage period and treatments. The TSS of the leather showed an increase for increasing storage duration, and it also increased as chiku concentration increased. As the TSS of chikou is much higher than that of guava (Table 2); it increased with step by

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step addition of chiku pulp. Storage had significantly ($P<0.05$) affected the TSS as its mean value increased from 68.59 to 71.10 from initial day to final day of storage. Maximum increase was detected in T_0 while minimum in T_5 (Figure 4). The results are similar with the findings of Sawant and Patil (2013) who stated that TSS of guava-chiku blend jam increased with increasing chiku concentration to the jam formulation. Parmar (2008) also deducted same results while evaluating guava-papaya mix leathers. A gradual intensification in total soluble solids of chiku jam throughout storage as also reported by Parmar and Jasrai (2014). Shakoor et al. (2015) described that the total soluble solid of guava bar increased with storage time. Masoodi et al. (1991) also testified that intensification in TSS also may be due to the transformation of polysaccharides into sugars. The escalation in TSS content might also be because of the concentrating effects as the product loses the moisture during storage period (Rani, 2011). The intensification of TSS during storage may be due to the restoration of starch and polysaccharide into sugars, and can also be due to moisture loss which inclines to enhance the total soluble solid (Shakoor et al., 2015).

Water activity of the guava-chiku leather showed a slight decrease for increasing storage duration (Figure 5). Mean values for storage decreased from 0.635 to 0.583 for overall 3 months period. All the leather samples showed decrease with maximum by T_3 while minimum in T_1 as shown (Figure 5). Shakoor et al. (2015) concluded that the water activity of guava bars decreased from 0.68 to 0.62 during storage duration of 3 months. Water activity has a great effect on the growth and survival microorganism in food products. In fact, the need for an expressive term to define the activities of microorganism in environs with condensed moistures help to establish the term water activity (Breene et al., 1988). The shelf life and stability of food products related to water activity can be enhanced by packaging (Irwandi et al., 1998). Azmat et al. (2017) reported a decrease from 0.69 to 0.64 for water activity in apple bar during storage duration. Decrease in water activity may be due to free water binding capacity of sucrose, acids and pectin, while a water activity level around 0.60 is considered safe for microbial outburst (Azmat et al., 2017).

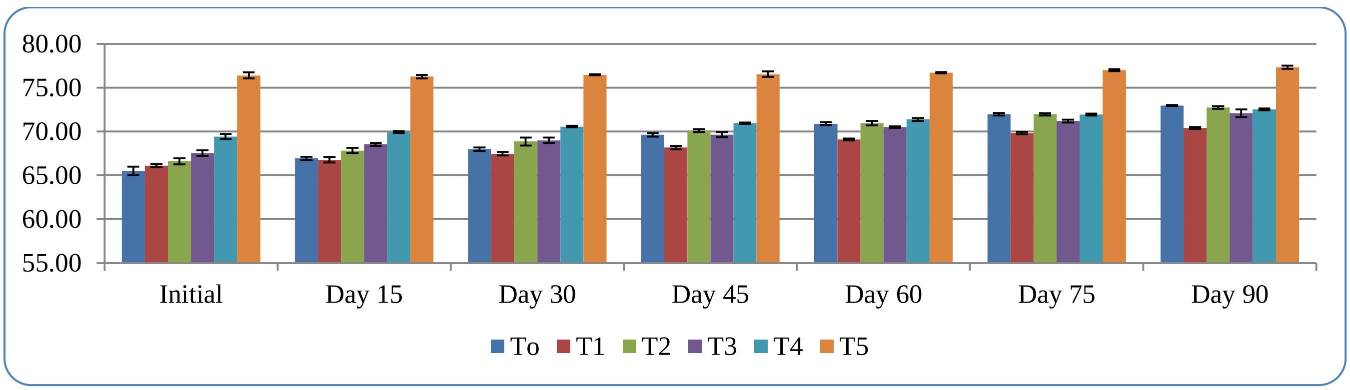

Figure 4. TSS of guava-chiku blended leather as affected by storage and treatments. The values are means of three replications (SD±).

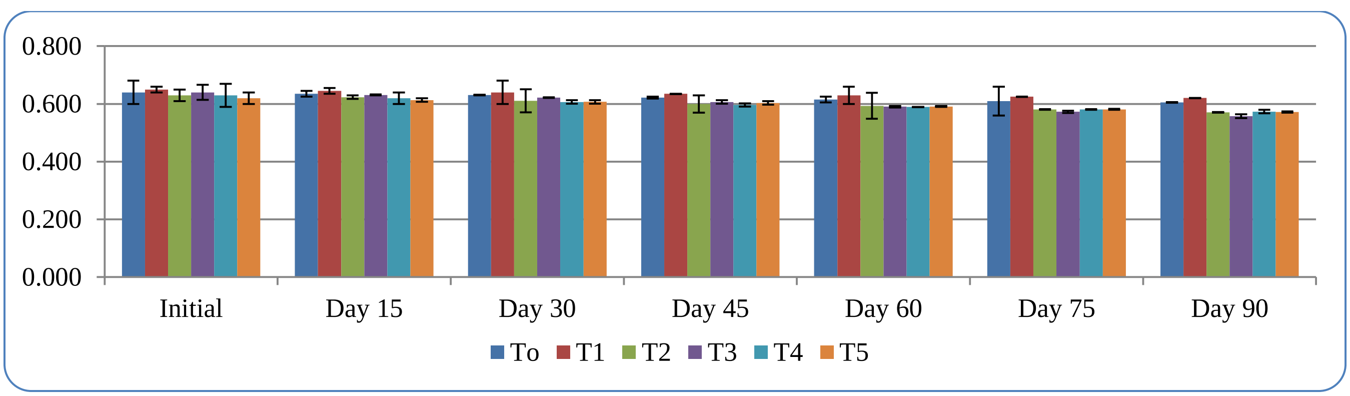

Figure 5. Water activity of guava-chiku blended leather as affected by storage and treatments. The values are means of three replications (SD±).

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Non-reducing sugar content of guava-chiku leather as affected by storage and treatments is shown in Figure 6. There was observed a decreasing trend in non-reducing sugar content of the leather during storage. The non-reducing sugar was increased with addition of chiku pulp to the formulation as clear from treatment effect. Mean values for storage decreased significant ($P<0.05$) from 3.58 to 3.23 for period of 3 months. All the samples showed decrease with maximum in T_0 and minimum in T_5 (Figure 6). These results are deeply similar to the findings of Sawant and Patil (2013) who prepared guava-sapota blend jam and pointed out the same results for non-reducing sugar. A decrease in non-reducing sugar in guava leather during storage was assessed by Khan et al. (2014). Likewise, Take et al. (2012) also concluded a similar decrease of non-reducing sugar. Decrease in non-reducing sugar of guava leather during storage was also being analyzed by Shakoor et al. (2015). The upturn in reducing sugar by the hydrolysis of total sugar could be reason for decrease in non-reducing sugar during the storage (Rani, 2011). This decrease could also be due to due change of non-reducing into reducing sugar.

Result regarding reducing sugar of guava-chiku leather as affected by storage and treatments is given in Figure 7. Storage period had significantly ($P<0.05$) increased the reducing sugar content of guava-chiku leather as well the treatments (pulp ratio) also increased the reducing sugar by subsequent addition of chiku pulp. As the concentration of reducing sugar is higher in chiku than guava (Table 2), there is an increasing trend in reducing sugar by adding chiku pulp to treatments. Storage mean values increased from 16.76 to 17.45 for a period of 3 months. All the leather samples showed increase with maximum in T_0 while minimum in T_5 (Figure 7). Our results for reducing sugar are in close proximity with that of Akhtar et al. (2010) who observed that reducing sugar content in guava-sapota jam increases as with increasing chiku pulp concentration. Our findings are similar with the results of other researchers (Khan et al., 2014) who reported an increase in reducing sugar of guava bar during storage and Divya et al. (2014) who detected increasing trend of sugar in sapota candy during storage. Shakoor et al. (2015) also concluded that the reducing sugar shows an increasing trend during storage in guava bars. The escalation in reducing sugars content may be due to inversion of non-reducing sugar, that are being converted to reducing sugar by hydrolysis process (Rani, 2011).

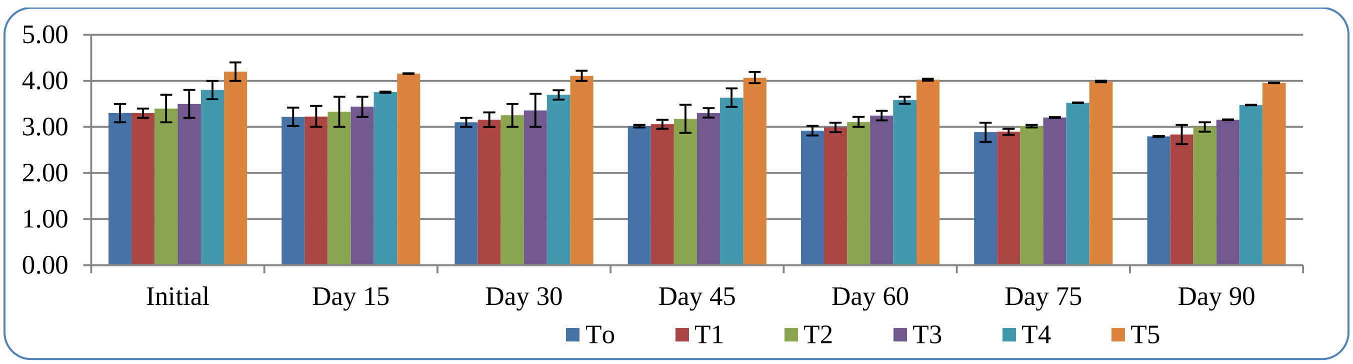

Figure 6. Non-reduicng sugar of guava-chiku blended leather as affected by storage and treatments. The values are means of three replications (SD±).

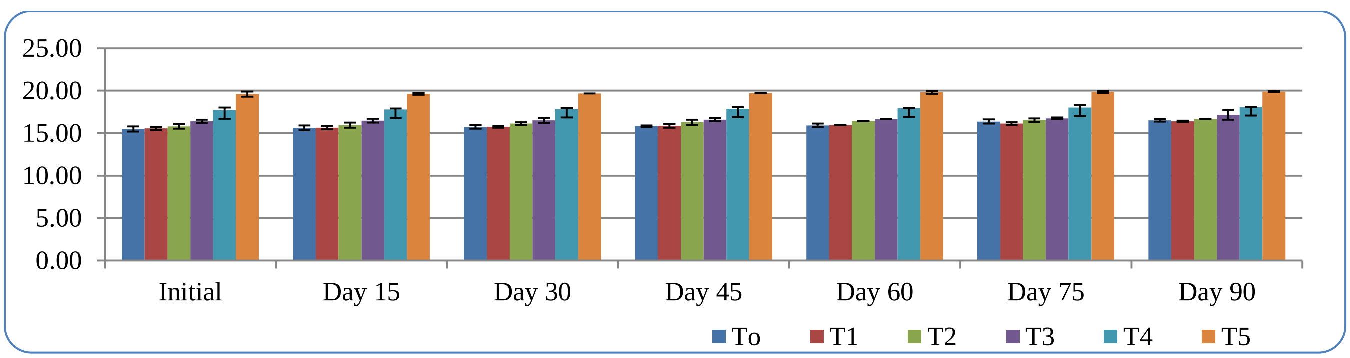

Figure 7. Reducing sugar of guava-chiku blended leather as affected by storage and treatments. The values are means of three replications (SD±).

Ascorbic acid content showed significant decrease for increasing storage period and also affected by treatments (Figure 8). In treatments; the ascorbic acid decreased with increasing chiku concentration as attributed to lower level of ascorbic acid in chiku (Table 2). Storage mean values decreased significantly (P<0.05) from 89.93 to 81.01. All leather samples showed significant decrease with highest decrease in T_0 while lowest decrease in T_5. The results of our research is matching with that of Parmar (2008) who evaluated guava-papaya mix leathers and pointed out that ascorbic acid is affected by pulp ratio of both the fruits. Divya et al. (2014) reported a decline in ascorbic acid content of sapota (chiku) candy during storage. In support to results, Harsimrat and Dhawan (1998) examined the decreased content of ascorbic acid during storage of guava bar. Shakoor et al. (2015) reported that ascorbic acid content of guava bar decreased significantly during 3 months storage. Similarly, a decreasing trend of ascorbic acid was found in guava bars by Khan *et al.*, (2014). The drop in ascorbic acid noticed could be due to the degradation of ascorbic acids to dehydro-ascorbic acid by means of oxidative and biochemical responses (Leite et al., 2006). The losses in ascorbic acid could be attributed to effects of processing, storage and exposure to light (Balerdi et al., 2005).

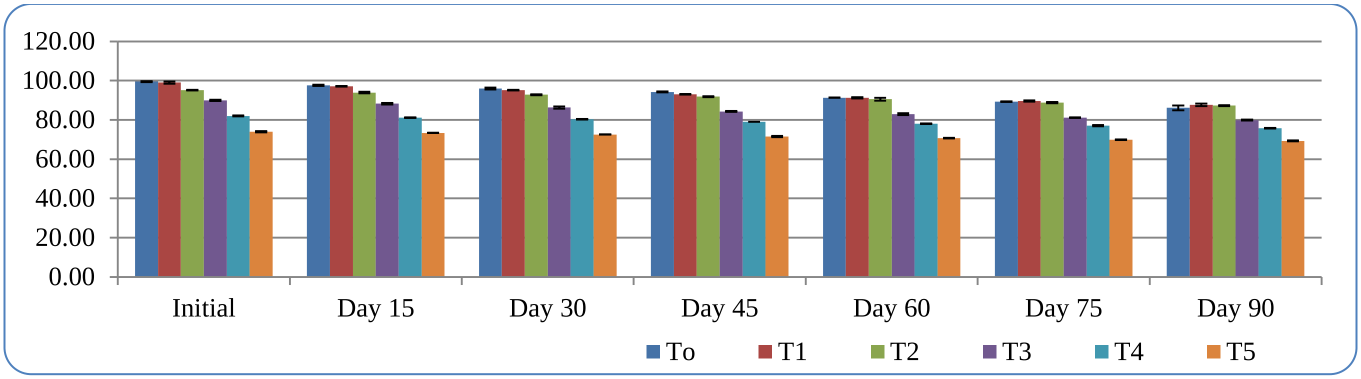

Figure 8. Ascorbic acid of guava-chiku blended leather as affected by storage and treatments. The values are means of three replications (SD±).

Table 3. Mean score of judges for color, taste, texture and overall acceptability of guava-chiku blended leather

Sensory attributes	T_0	T_1	T_2	T_3	T_4	T_5
Color	5.40e	5.43d	7.01b	6.75c	7.17b	8.14a
Taste	5.23f	5.86e	6.01d	6.91c	7.27b	8.08a
Texture	6.04d	5.80e	6.86b	6.57c	6.84b	7.91a
Overall acceptability	5.55e	5.69d	6.63c	6.74c	7.09b	8.03a

Sensory analysis

Guava-chiku leather samples were organoleptically analyzed for color, taste, texture and overall acceptability during the entire storage period at 15 days interval. The mean score of judges for color, taste, texture and overall acceptability are shown in Table 3. All the samples showed decrease in sensory attributes for increasing storage period; with minimum decrease in treatment T_5. It was resulted that the treatment T_5 that was made from 50:50 combination of guava and chiku pulp showed highest mean scores of sensory quality and was most acceptable to the judges.

CONCLUSION

This study demonstrated the development and storage studies of guava and chiku blended fruit leathers. It has concluded that the physicochemical and sensory quality of the leather there is affected by treatments which is pulp ratio and by storage duration. The treatment which contained 50% guava and 50% chiku fruits showed best results for physicochemical and sensory quality attributes. The results of this study can be helpful for large scale production of blended fruit leathers.

CONFLICTS OF INTEREST

The authors declared no conflict of interest. The funders had no part in the design, collection analyses and interpretation and writing of short communication.

AUTHOR'S CONTRIBUTION

All authors contributed and supported towards writing of this manuscript.

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